AUTOMOBILE ENGINEER

DESIGN · PRODUCTION · MATERIALS

Vol. 42 No. 560. NOVEMBER 27, 1952 PRICE: 3s. 6d.

RGI

LOOK where goods are loaded

or passengers are carried

...YOU SEE DURALUMIN

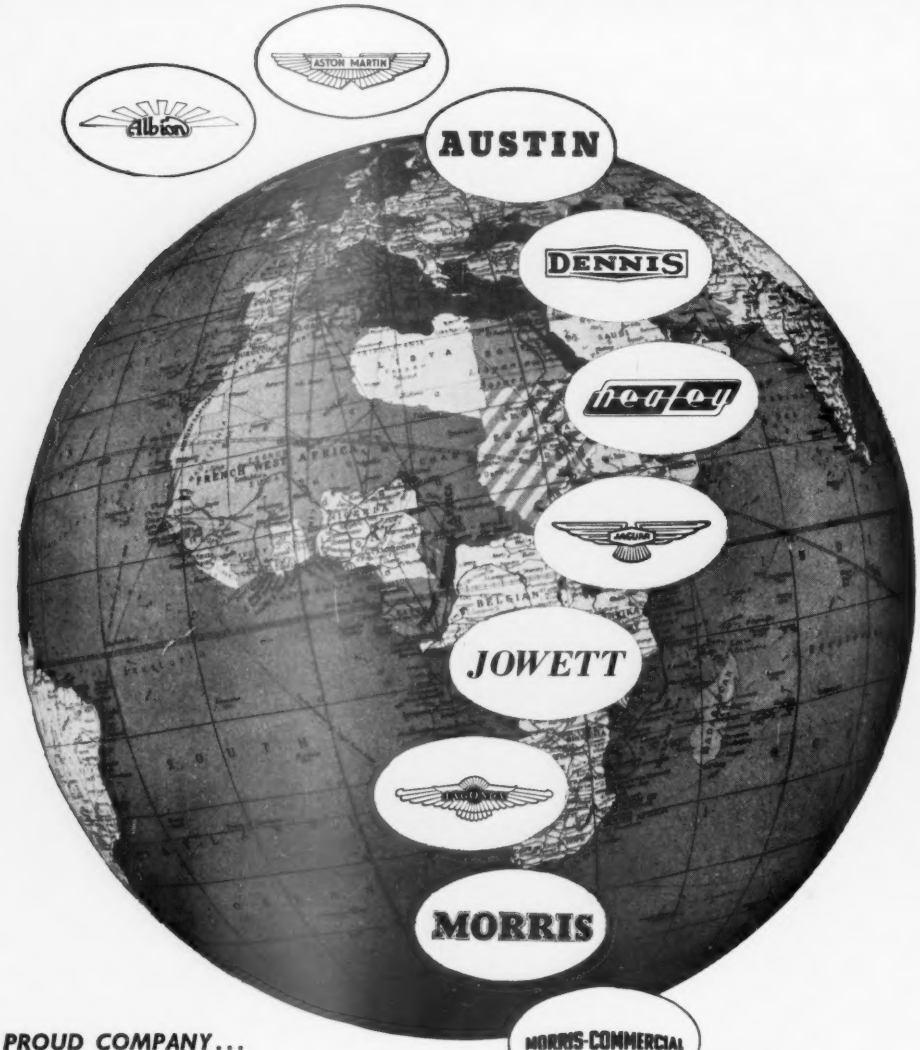
REGD. TRADE MARK

Look where you will in the world of transport and you will almost certainly see "Duralumin". It is only one-third the weight of steel and yet as strong. By its use many operating costs can be reduced, and carrying capacity increased. Petrol consumption is lower, and there is less wear on tyres. The decreased overall weight of the vehicle saves the cost of the road fund licence. As "Duralumin" does not rust and can be left unpainted, maintenance costs are much decreased.

The properties of "Duralumin" include a remarkable capacity for absorbing shocks. It is non-toxic, hygienic and easily cleaned — of importance where the carriage of foodstuffs is concerned—and it does not warp when wet.

Whilst shortages exist at present, this is a passing phase. Now is the time to consider the use of aluminium alloys in the design of vehicles of all descriptions, so that the plans may be complete when the needs of rearmament are satisfied. Our Development Department will advise entirely without obligation.

JAMES BOOTH AND COMPANY LIMITED ARGYLE STREET WORKS · BIRMINGHAM · 7



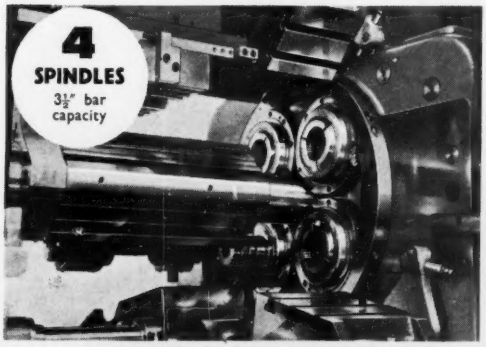
PROUD COMPANY...

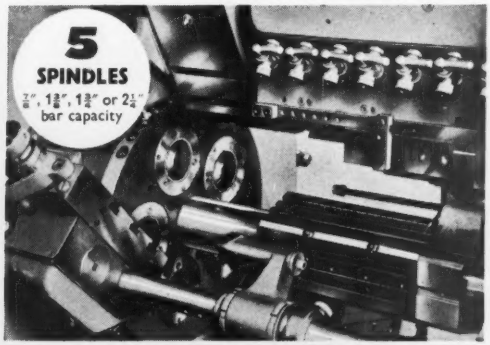
The names shown here are famous throughout the motoring world. *Mintex* — having its own share of fame — is proud to be associated with them; they are the names of vehicles produced by manufacturers who fit *Mintex* as original equipment.

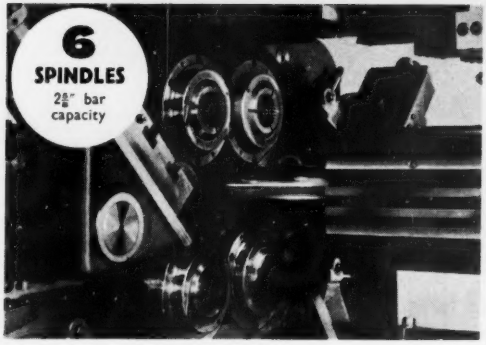
For complete reliability you can depend on **MINTEX**

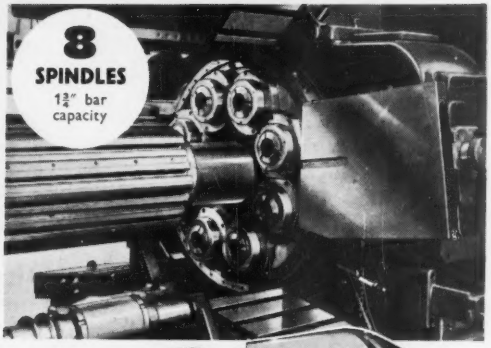
MINTEX BRAKE & CLUTCH LINERS are manufactured by BRITISH BELTING & ASBESTOS LTD., CLECKHEATON, YORKSHIRE and are obtainable from all Mintex Service Depots and stockists.
B.B.A. are also the manufacturers of SCANDURA, the original P.V.C. fireproof conveyor belt.

FOUR, FIVE, SIX AND EIGHT SPINDLE AUTOMATICS provide production engineers with new opportunities to increase output and lower costs

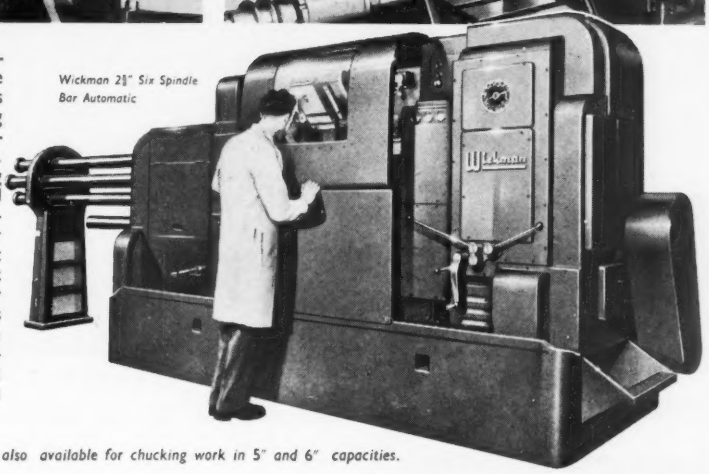








Fast producing Wickman Multi-spindle Automatics can now be applied to a wider range of jobs than ever before. The tooling opportunities can be easily visualised from the illustrations above. The Wickman patent auto-setting mechanism is incorporated in all machines of the range and alterations to tool feed strokes and bar feed are accomplished without cam changing. The full fast approach stroke is unaltered by this mechanism, setting up is simplified and change-over time reduced—that's why these automatics can be considered for short run jobs as well as long runs on one component.



Wickman 2⅛" Six Spindle Bar Automatic

Wickman 5-spindle automatics are also available for chucking work in 5" and 6" capacities.

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to keep heat IN...

Photograph by courtesy of North Thames Gas Board.

Hot tar, for example,

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into road tankers and has to be kept hot enough for immediate use when it is delivered; perhaps several hours later. The engineers of the North Thames Gas Board were able to solve this problem by wrapping the tank with a 3-inch 'Fibreglass' wired mattress protected from the weather by sheet-metal cladding.

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"Oh! . . . twist drills . . . I never bother to line them up at all — Monks & Crane carry such phenomenal stocks."

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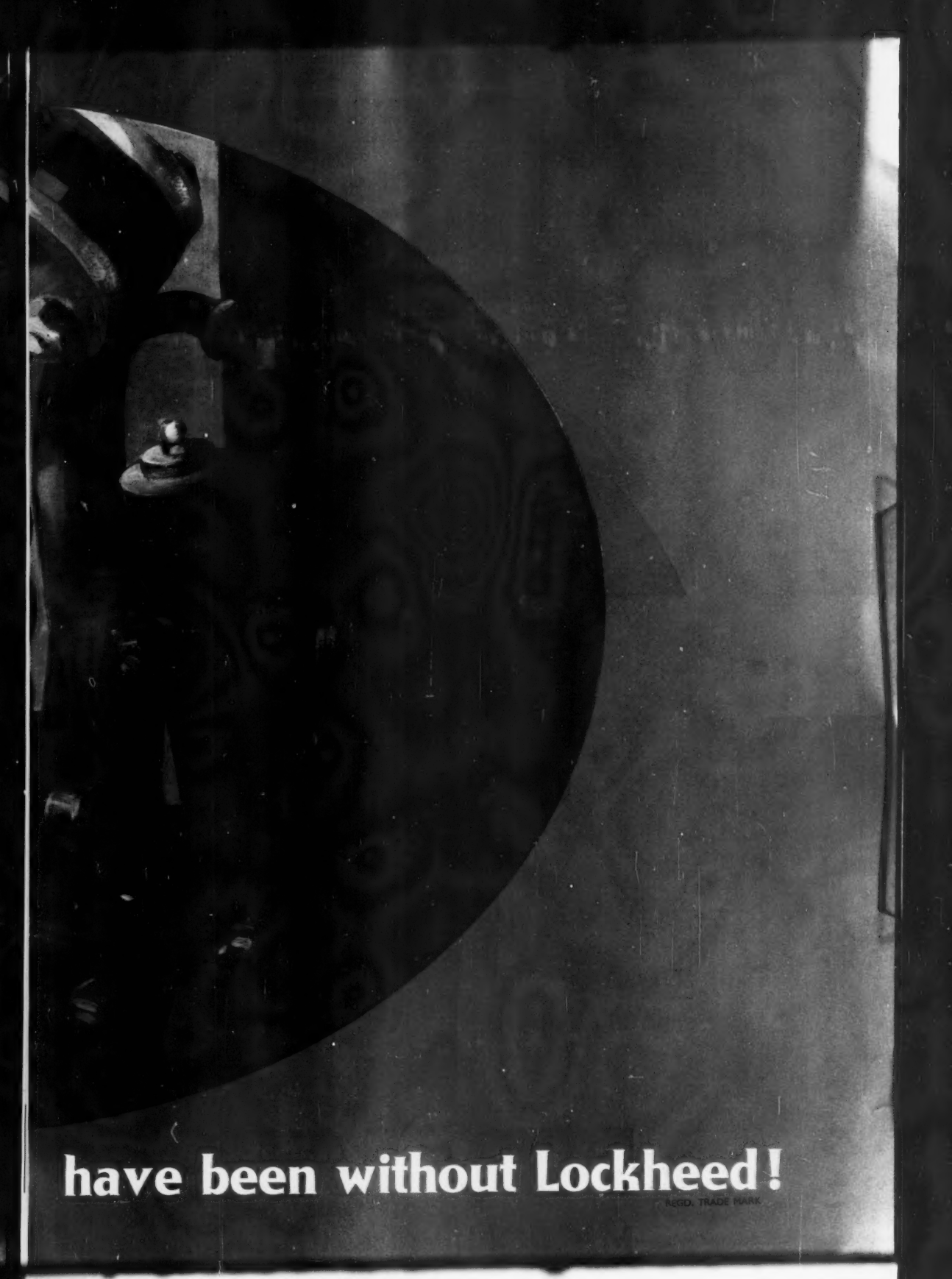
What a headache it would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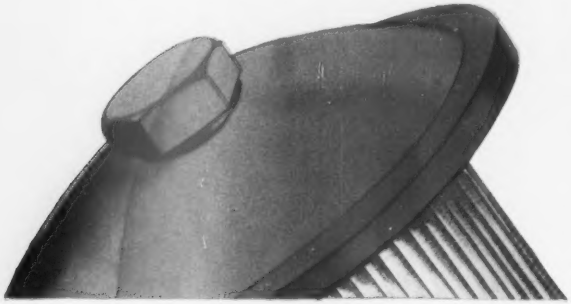
WE WILL COLLECT. Too small to be seen, too small to be stopped by ineffective filters, but nevertheless able to carry out vicious attacks on vital points.

It was to beat these enemies of durability that we developed the special plastic impregnated paper filters and as a result, they really do possess ....



....power of arrest

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COMPANY LIMITED,
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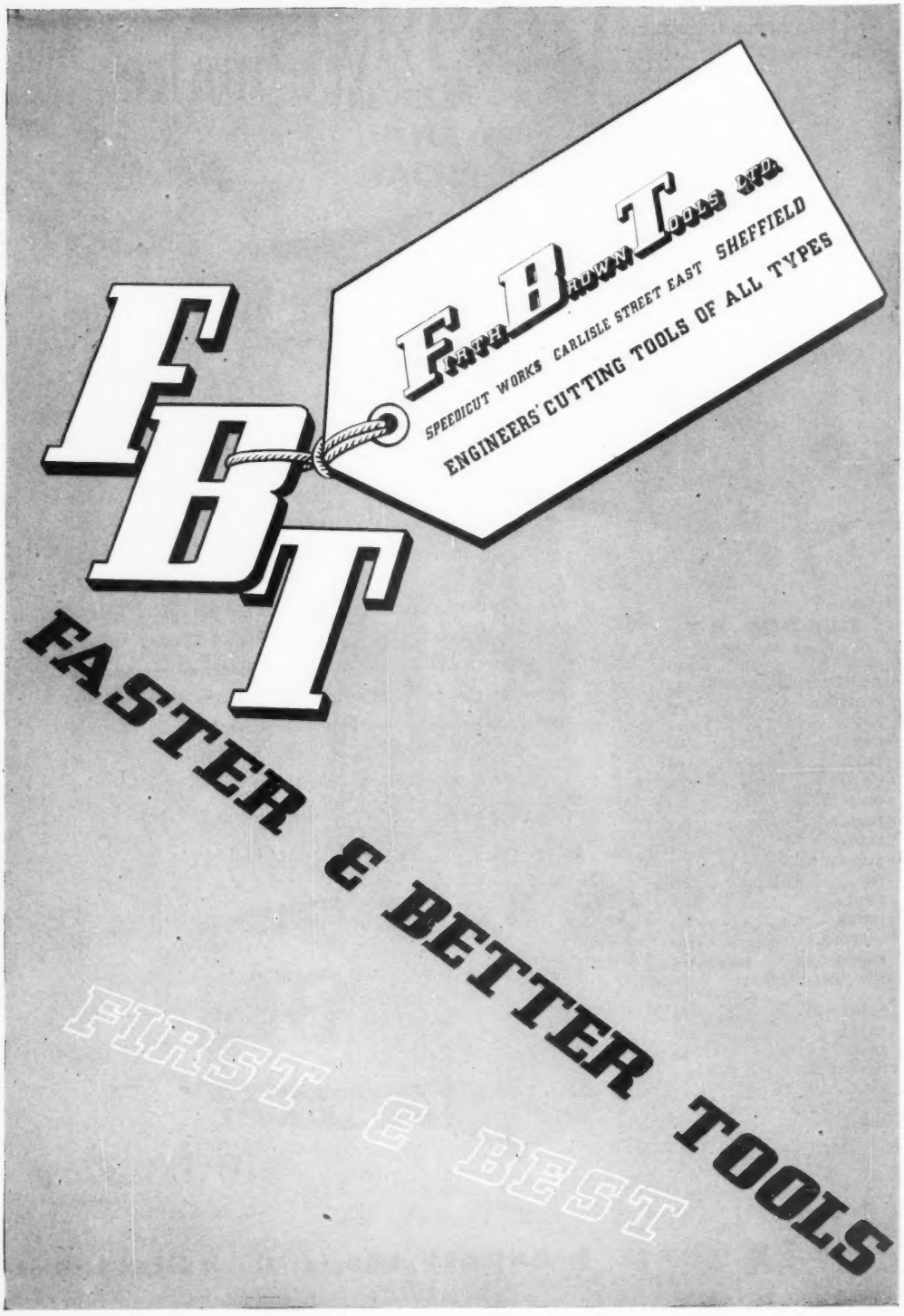
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ENGINEERS' CUTTING TOOLS OF ALL TYPES
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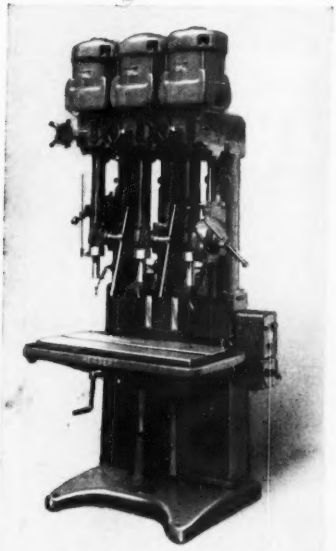
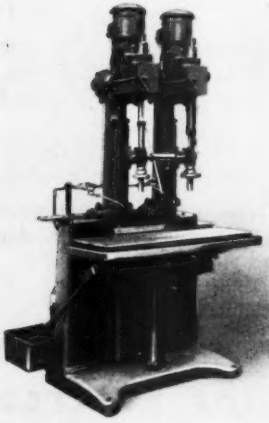
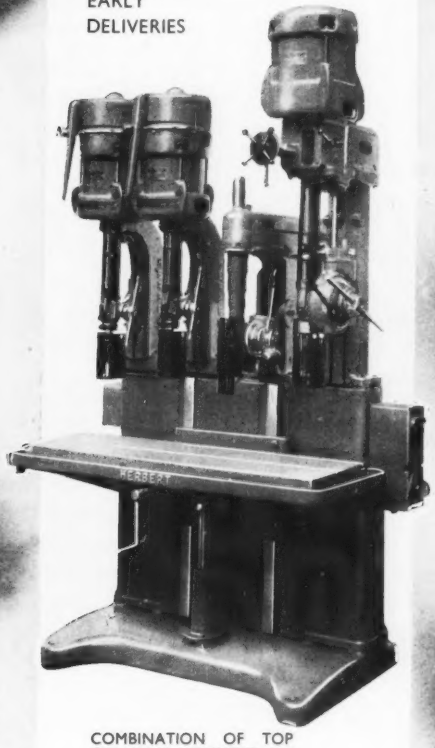


TYPE V THREE SPINDLE FITTED WITH ONE GEARED AND TWO PLAIN SPINDLES AUTOMATIC REVERSE FOR TAPPING IS FITTED TO THE LEFT-HAND SPINDLE.

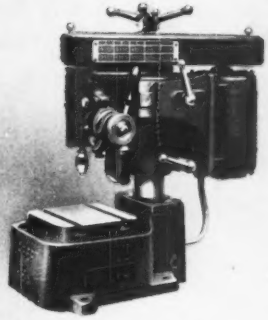


TWO TYPE C TOP COLUMNS MOUNTED ON A FOUR-SPINDLE BASE. LEFT-HAND COLUMN IS ADJUSTABLE AND A TELESCOPIC CONNECTION WHICH ENABLES SPINDLES TO BE FED SIMULTANEOUSLY IS FITTED BETWEEN THE SPINDLES.

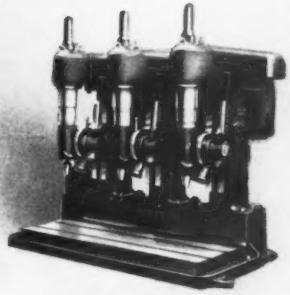


COMBINATION OF TOP COLUMNS MOUNTED ON A SINGLE BASE. SPEED RANGE 74 TO 5600 r.p.m.

TYPE M MULTI-SPINDLE



TYPE B BENCH



TYPE H THREE-SPINDLE BENCH

ALFRED HERBERT LTD
COVENTRY

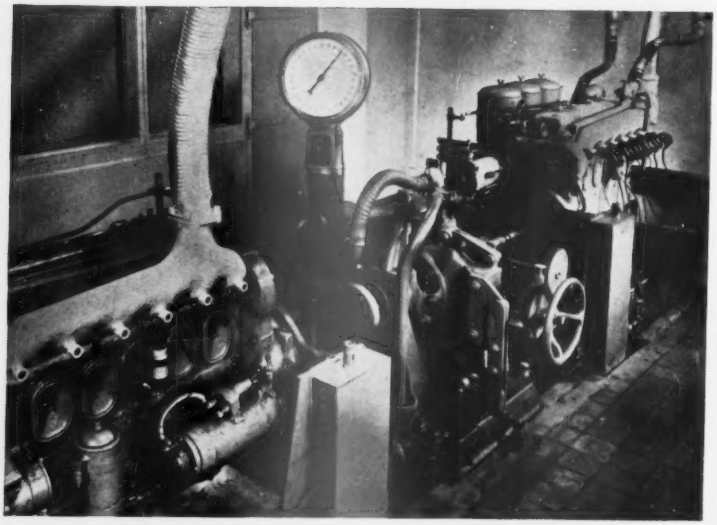


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Illustration shows a Froude Dynamometer at the works of Messrs. Mackay Industrial Equipment Ltd.

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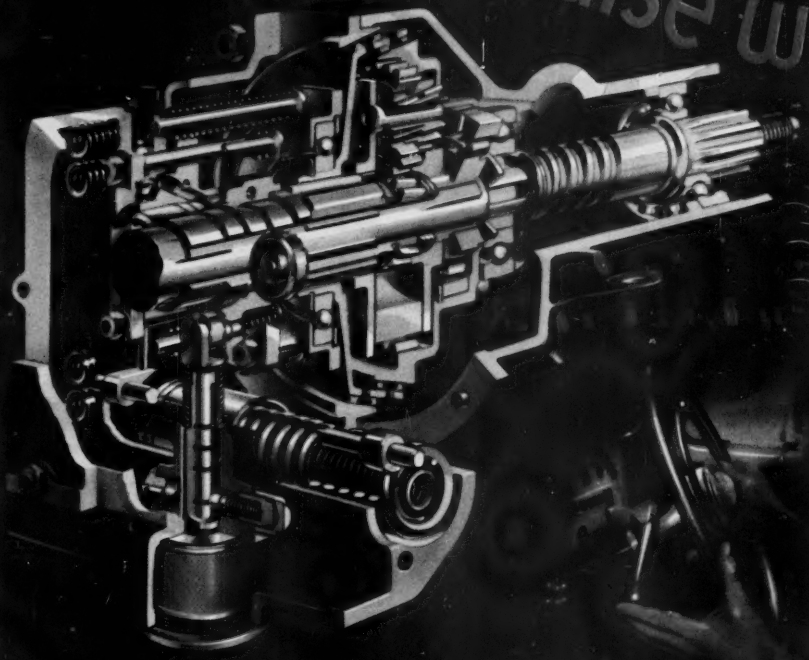
The illustrations show, Fig. 1. the Layrub Shaft installed on a Jowett 'Javelin' car, Fig. 2. and Fig. 3. typical installations used very extensively by the leading Commercial Vehicle manufacturers at home and abroad.
Write us for technical catalogue which we shall be pleased to mail you.
LAYCOCK ENGINEERING LTD - MILLHOUSES - SHEFFIELD - 8

we cruise with ease

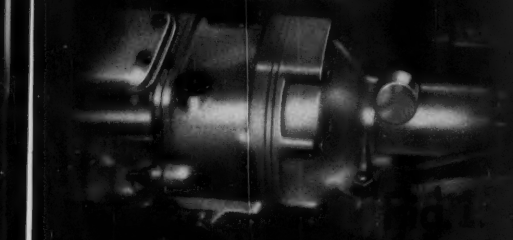


The LAYCOCK-de NORMANVILLE OVERDRIVE is a self-contained unit fitted to the rear of the gearbox (*Fig.* 1). It provides the so-much-desired extra high gear. (On a well-known make of car with a top gear ratio of 4.625 to 1, the overdrive raises it to 3.6 to 1).

On this particular make of car the overdrive is engaged instantaneously by the mere finger-tip movement of the gear lever, from top to overdrive, (*Fig.* 2 shows normal top gear position, *Fig.* 3 overdrive), and without movement of foot controls (*Fig.* 4). Full power is continuously transmitted, the operation being immediate, effortless and indetectable.

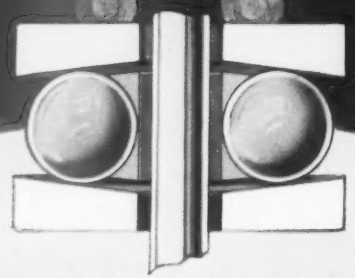
Control of this overdrive can be arranged in a variety of ways, by direct mechanical linkage and manual operation, or by electrical centrifugal governor and/or solenoid to give automatic engagement, with provision for overriding control by the driver.

Technical leaflet describing the complete operation of this overdrive will be gladly mailed you on request.



The Laycock de Normanville overdrive

ACCURATE SPEED CONTROL



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The services of our engineers are at your disposal.

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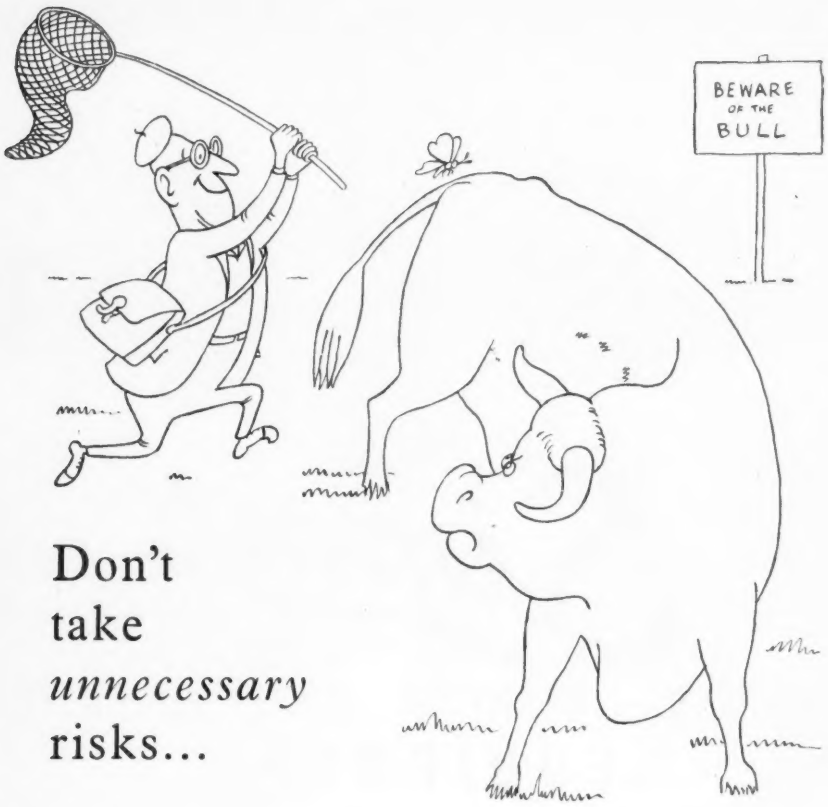

Don't take *unnecessary* risks...

IT looks a 'natural'—a rare and golden opportunity; but see the trouble it causes this near-sighted naturalist. Yet it's so *easy* to be misled by appearances—every day someone or other is finding himself on the horns of a dilemma through leaping before he looks. Not only light-hearted butterfly hunters, but hard-headed business men—it's just as easy to be led astray in the factory as in the field. You take a leap in the dark, for instance, every time you buy important components of uncertain quality. And speaking of leaps, let's talk about Springs . . .

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Our wide experience is at your service and we shall be pleased to co-operate with you on your own production problems.
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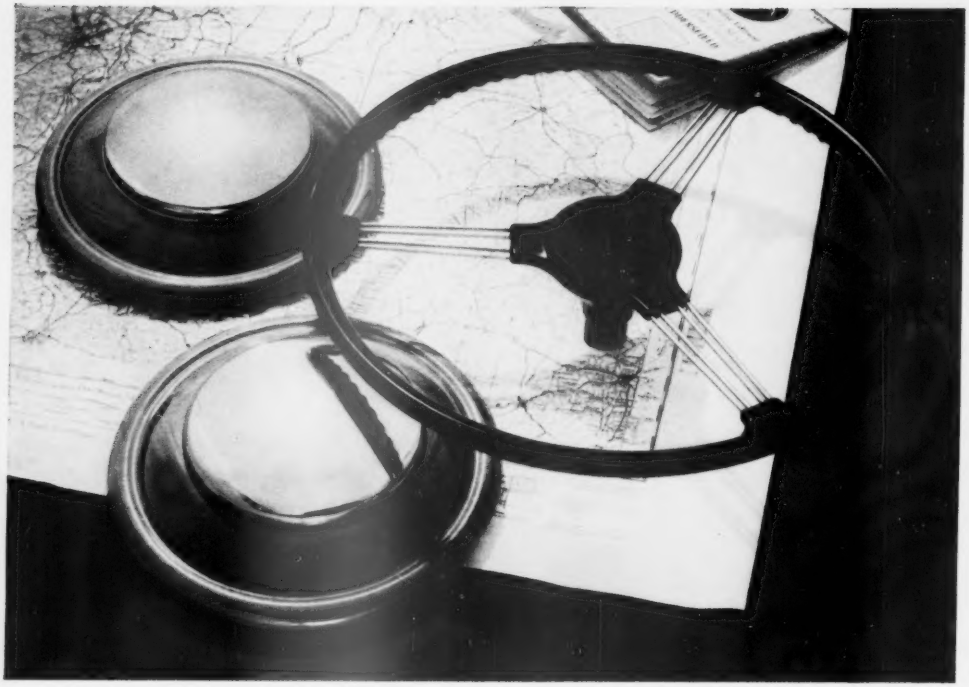

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When the nation's needs permit, "Silver Fox" will be available to the discriminating motorist in ever-increasing quantities.

Our colour photograph shows Hub caps by courtesy of the Ford Motor Company. Steering Wheel by courtesy of Wilmot **Breeden Limited.**

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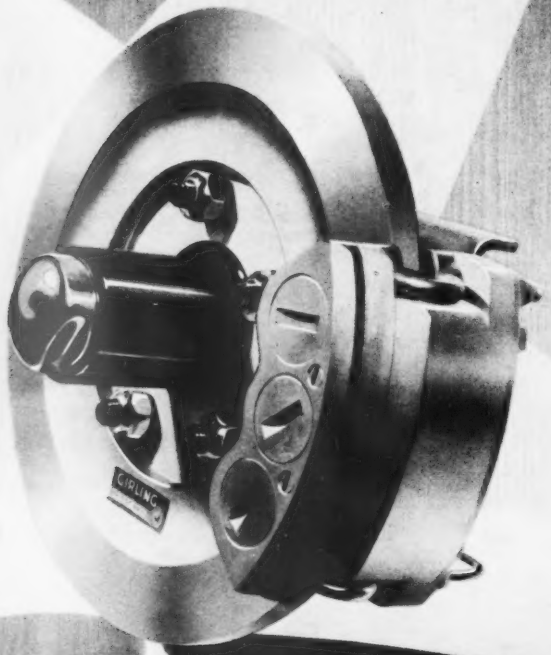
ANOTHER GIRLING FIRST



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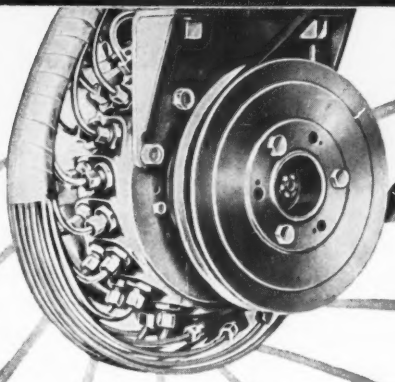

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Eminently suited to fleet conversion.

All 40 main points lubricated individually.

Lubrication carried out on a definite mileage basis.

Oil fed under high pressure

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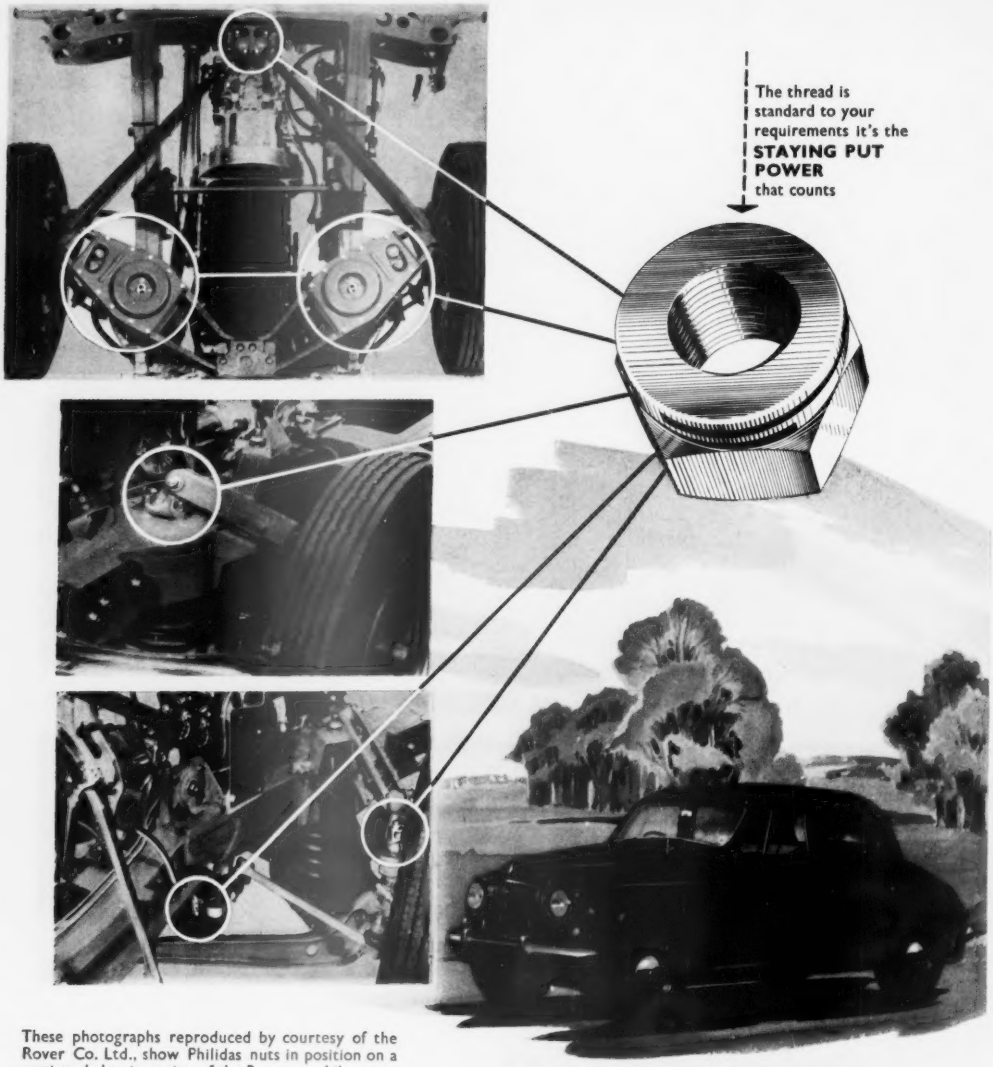

These photographs reproduced by courtesy of the Rover Co. Ltd., show Philidas nuts in position on a sectioned chassis section of the Rover car. Like many other leading motor manufacturers, the Rover Co. use Philidas nuts because :

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- Their efficiency is unaffected by heat, vibration, oil contamination or by repeated applications and removals.
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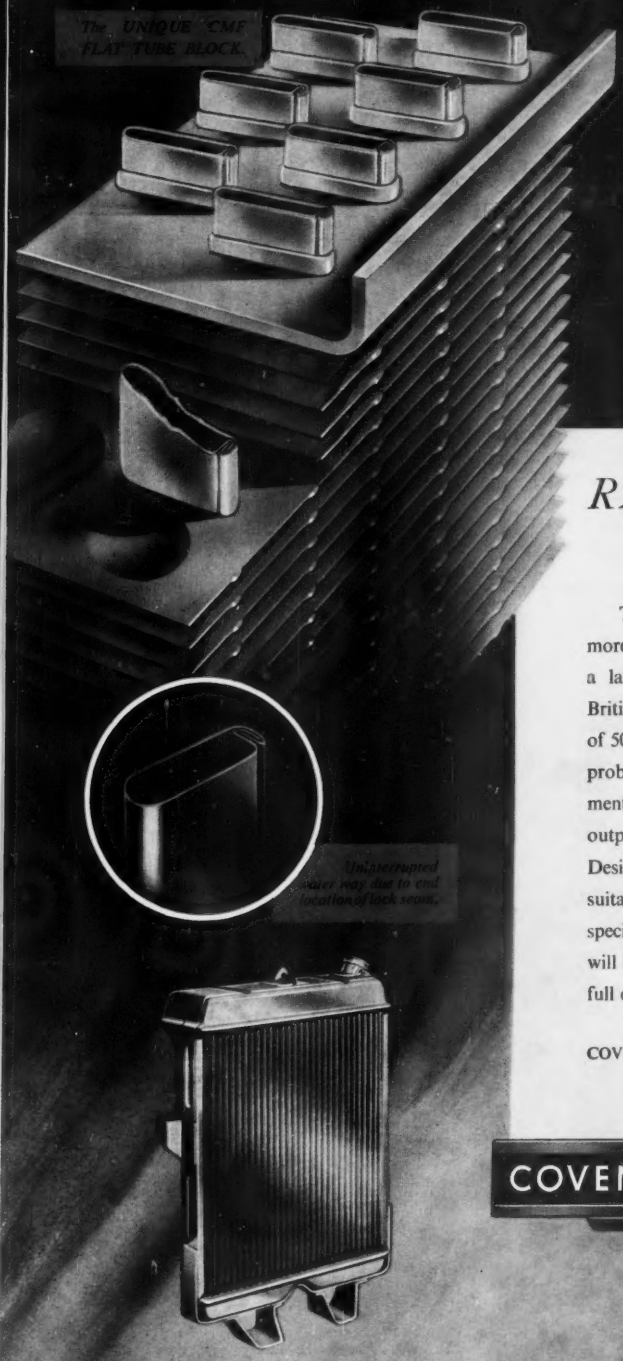

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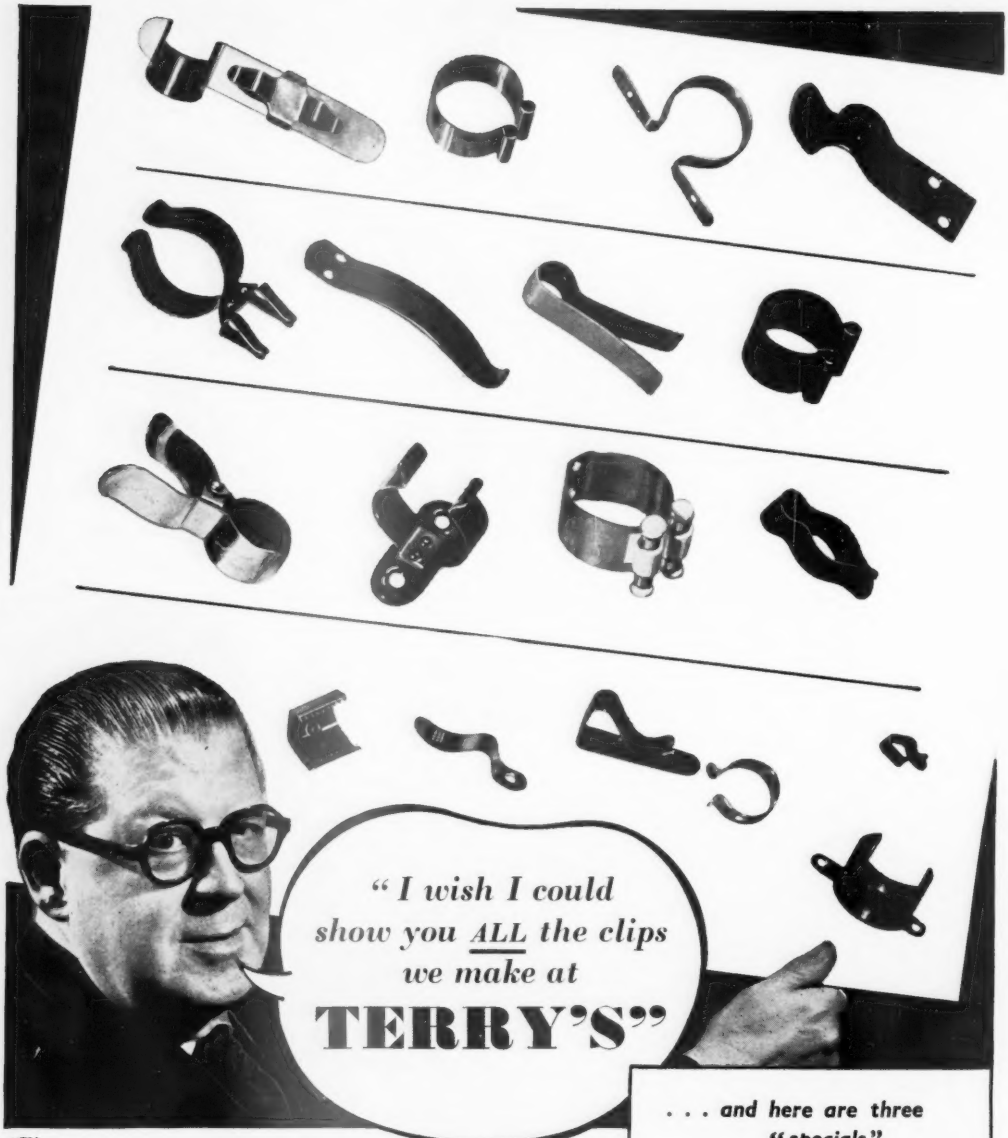

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The progress of our country—summed up by the Right Honourable Clem Attlee as 'the Mess of Centuries'—shows few more deplorable examples of Free Enterprise than the birth of this wretched firm. Having devised a power tool some 60% lighter and smaller than anything previous, the Brothers Desoutter found that established toolmakers took little interest in it, describing it, indeed, as " an ingenious toy ".

In a more advanced Society where Officials Know Best (vide **"The Socialist Case"**, by a Mr. Jay curiously enough) the matter would no doubt have ended in some Ministry of Inventions with a dossier marked : TOOLS POWER SMALL DESOUTTER CORRESPONDENCE IN CONNECTION WITH PASSED TO YOU PASSED TO YOU PASSED TO YOU FILE . . FILED.

Fired, however, by personal enterprise (and piqued by the 'ingenious toy' smear) the Brothers Desoutter emptied their money boxes, borrowed 3/- from the milkman, extracted 5/- from the gas meter, and set up on their own. There follows a sorry tale of tools made and sold all over the world in ever increasing numbers and (*oh! the shame of it*) with profit. It is an Inspiring Thought—is not it ?—that in the six short years following the war that sort of nonsense was being got well under control.

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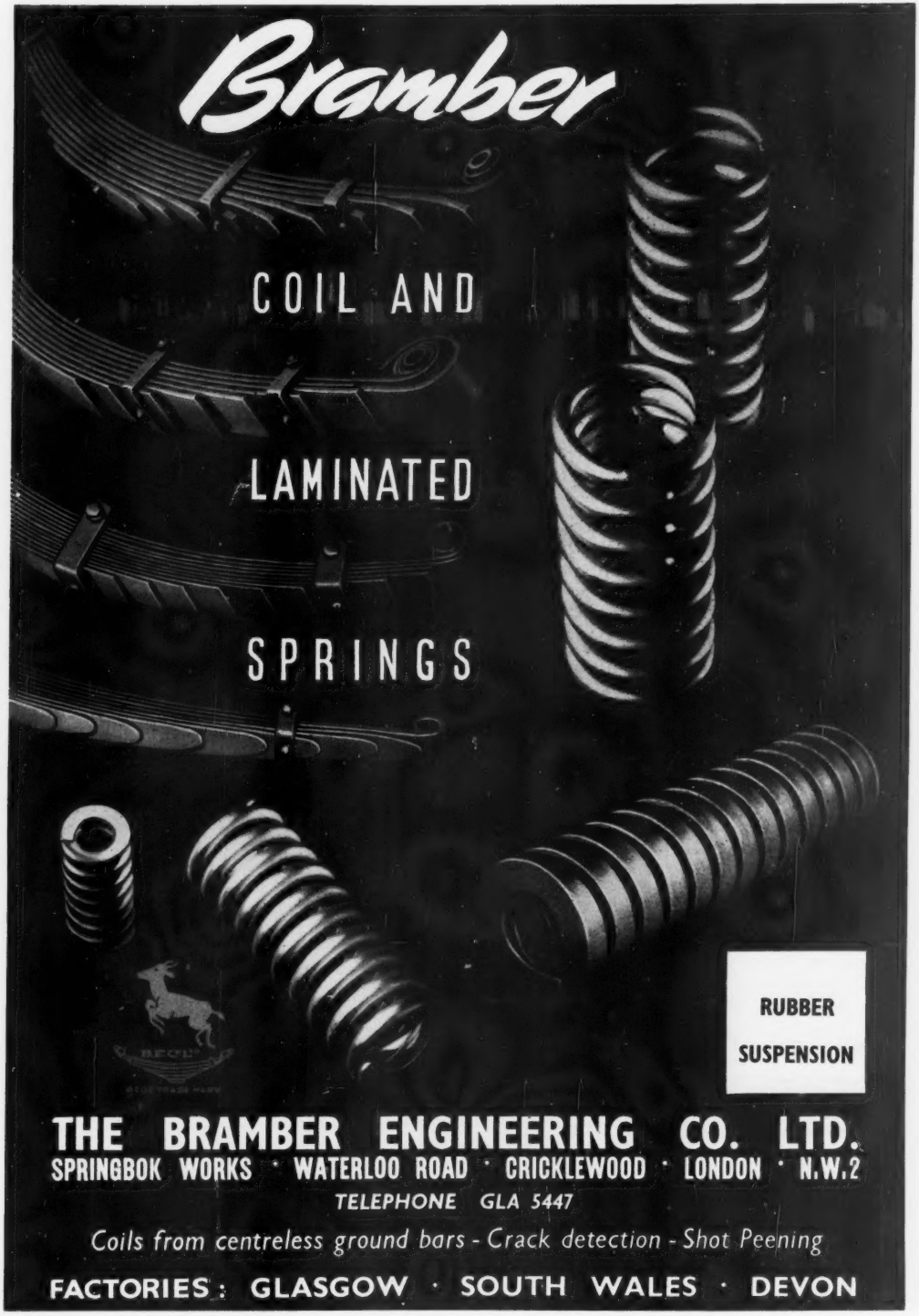
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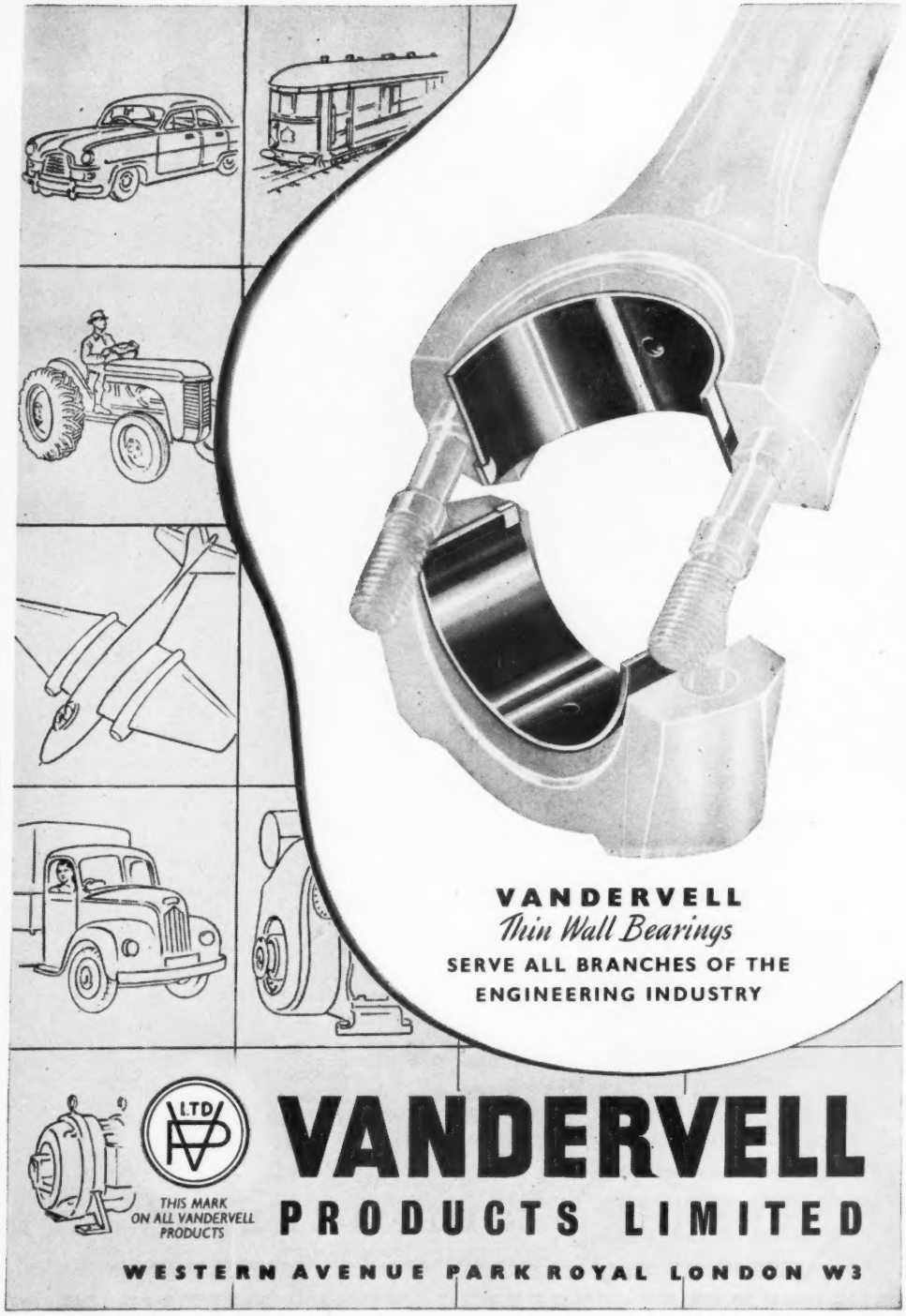
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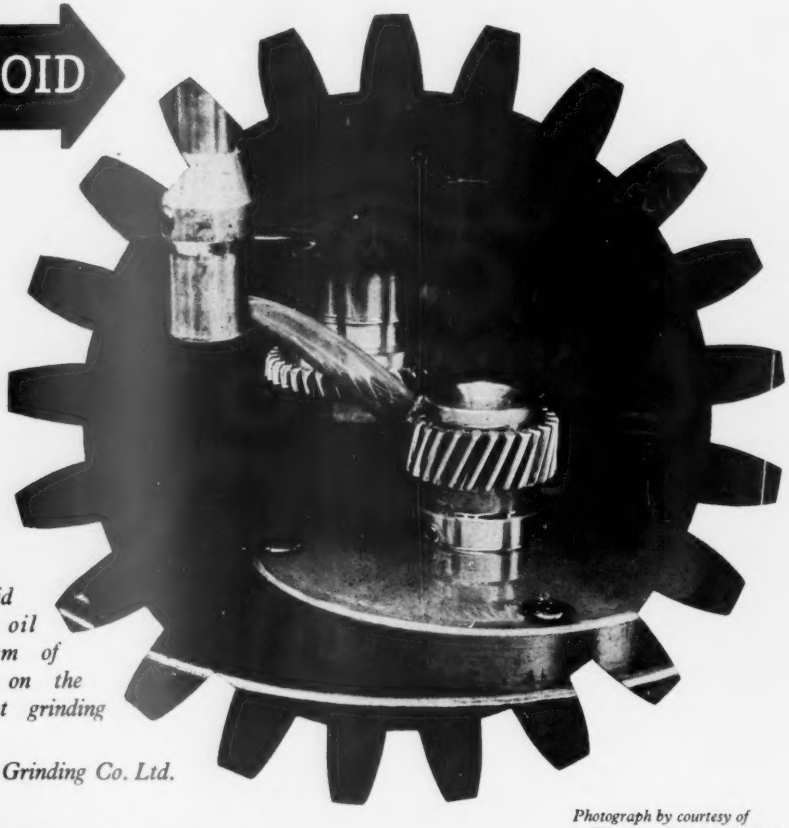

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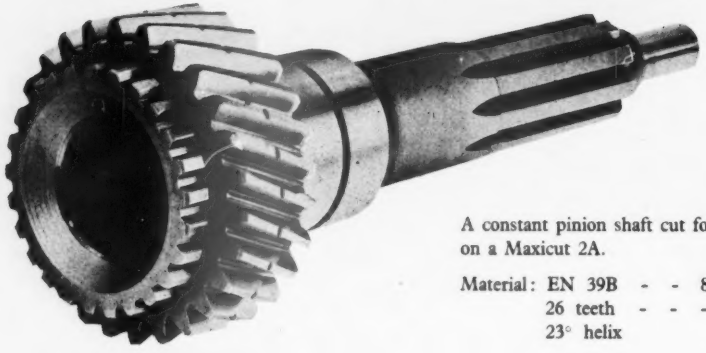

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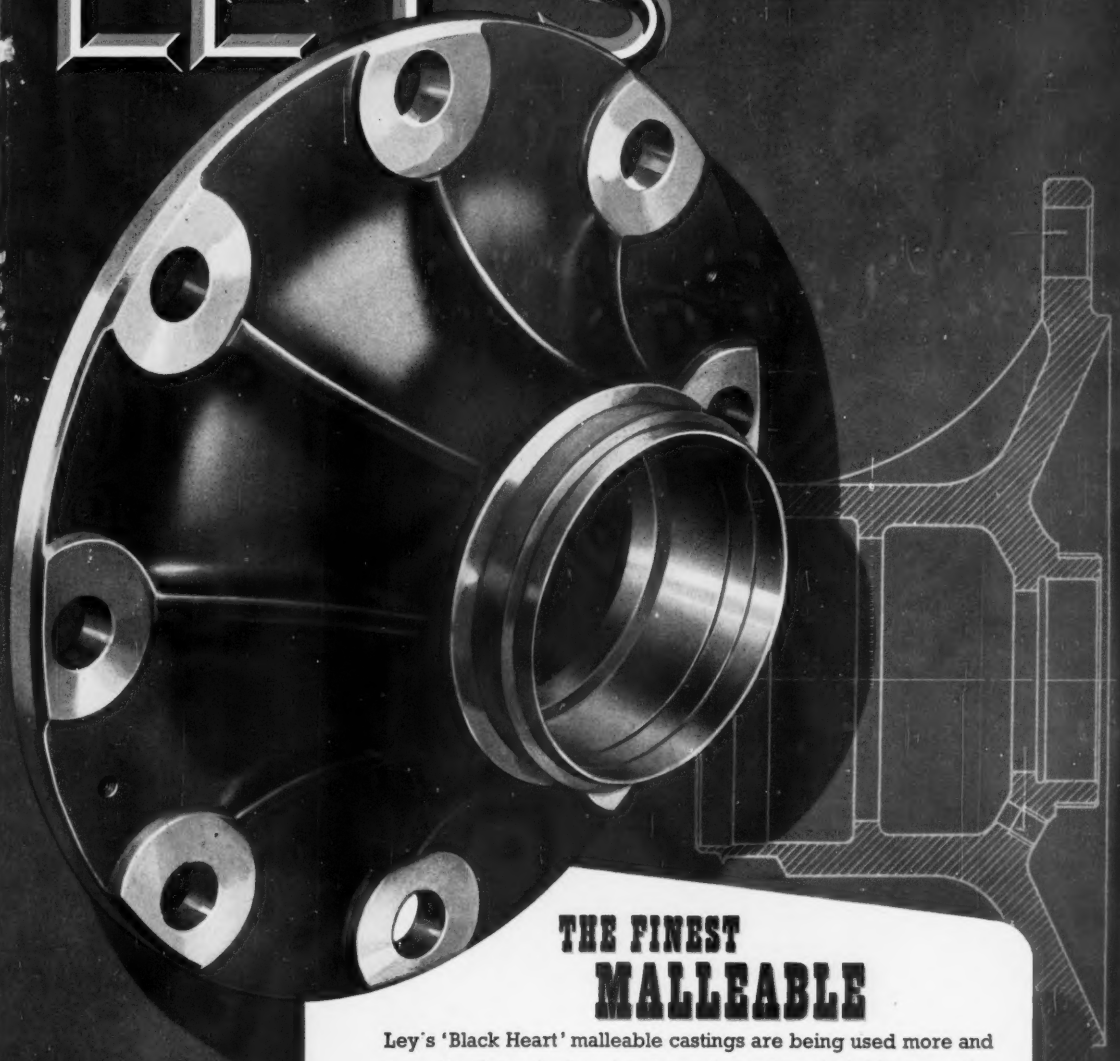

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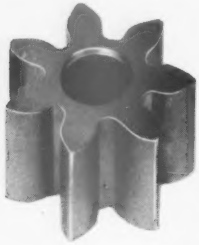

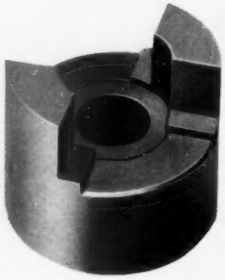

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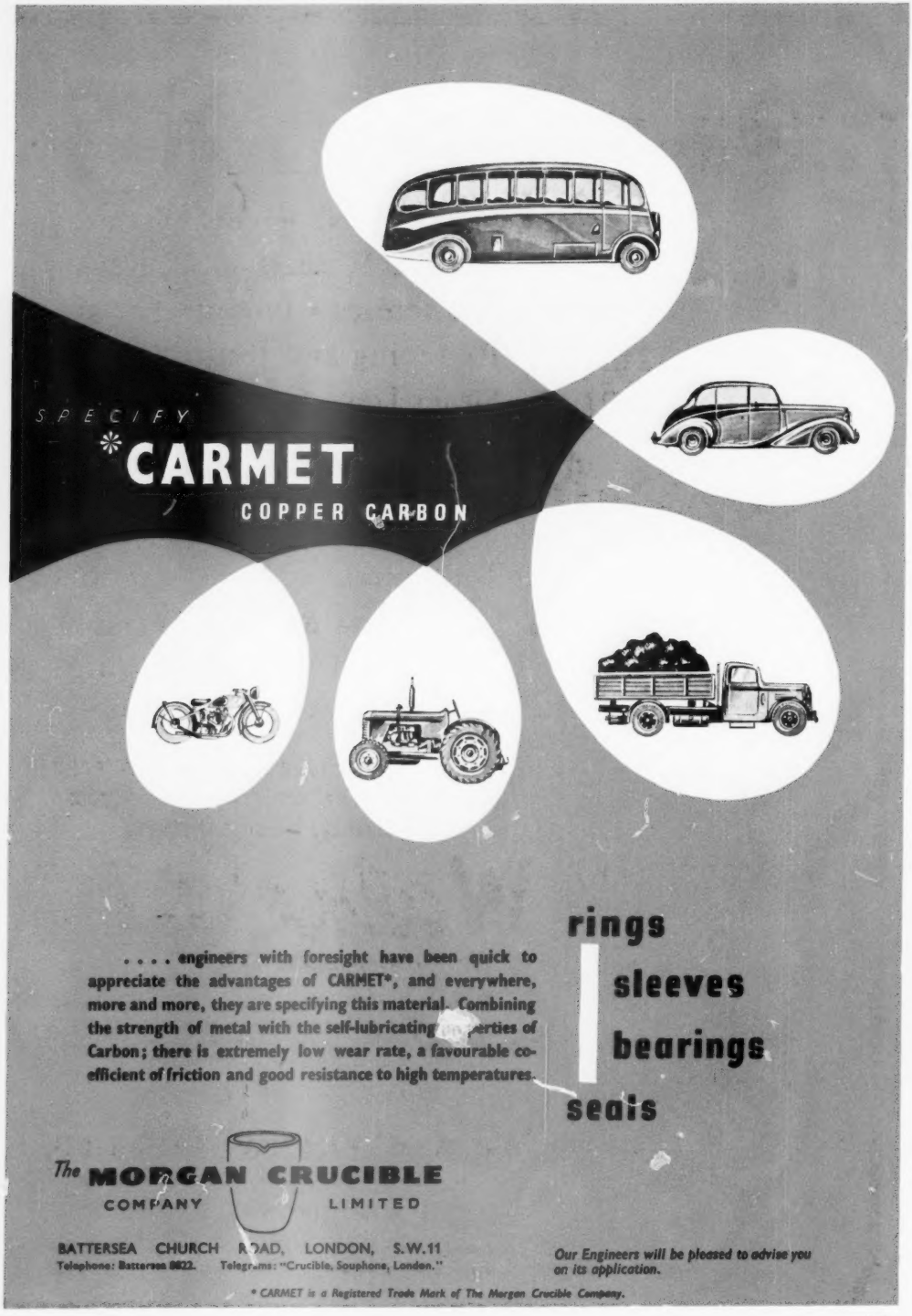
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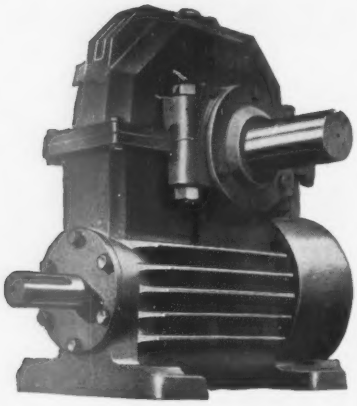

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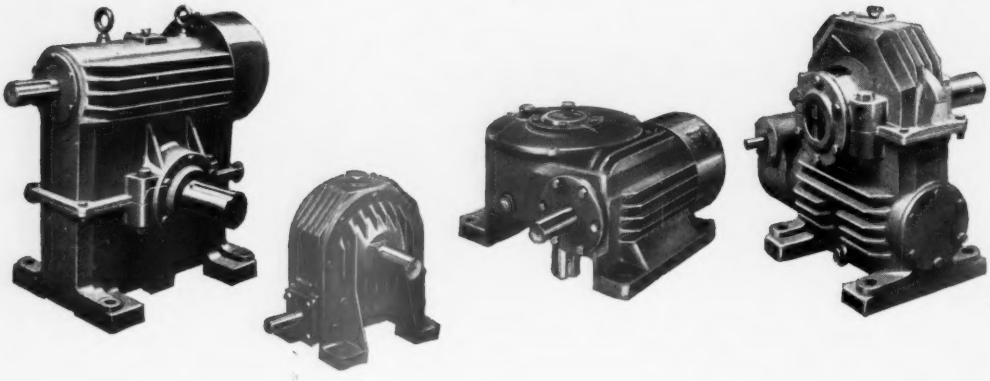

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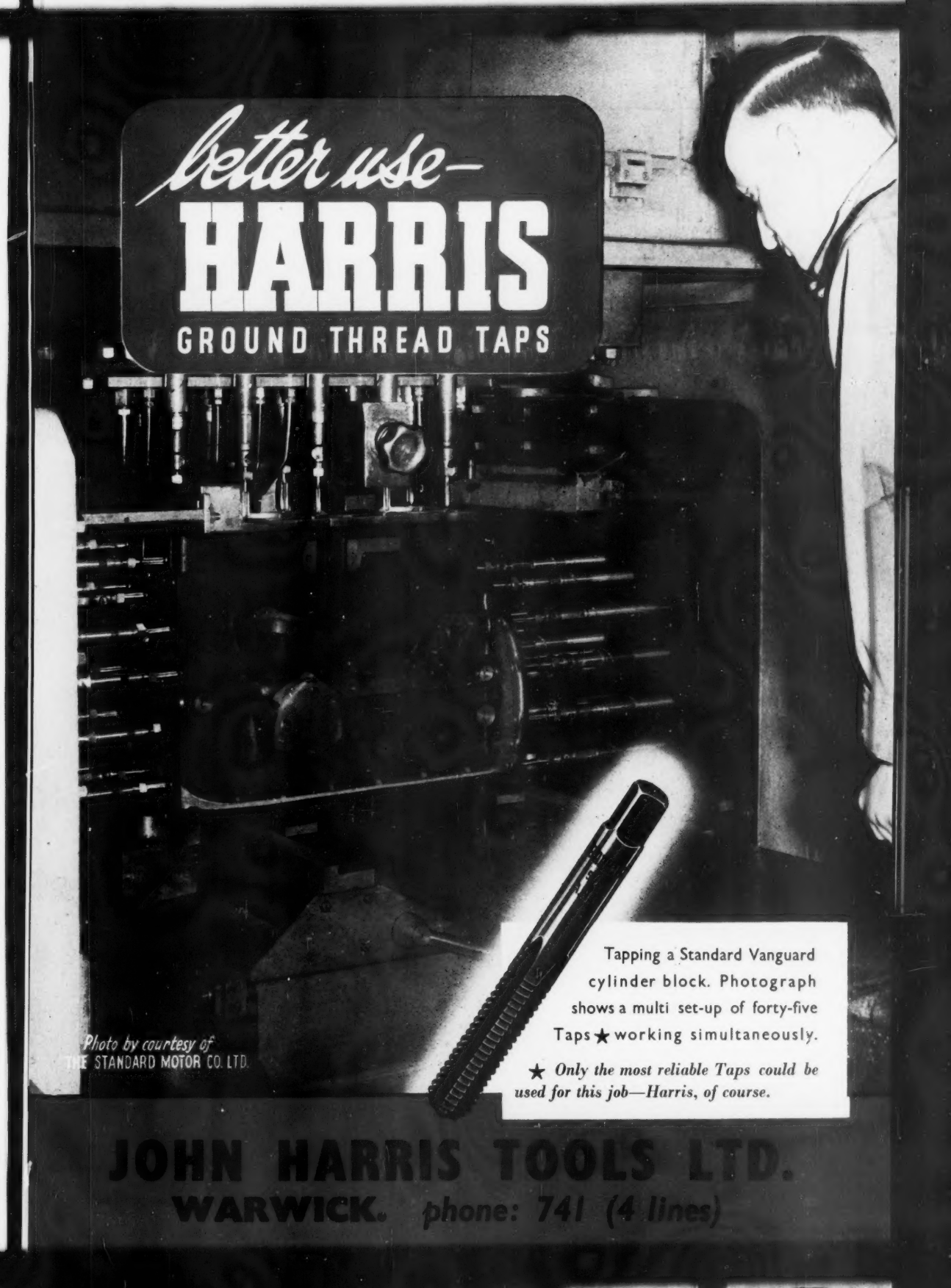

Tapping a Standard Vanguard cylinder block. Photograph shows a multi set-up of forty-five Taps ★ working simultaneously.

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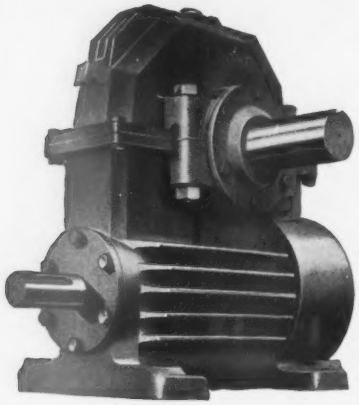

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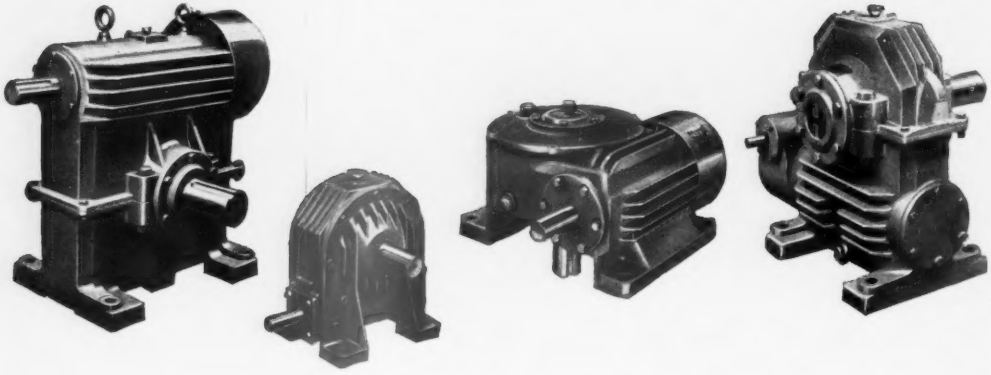

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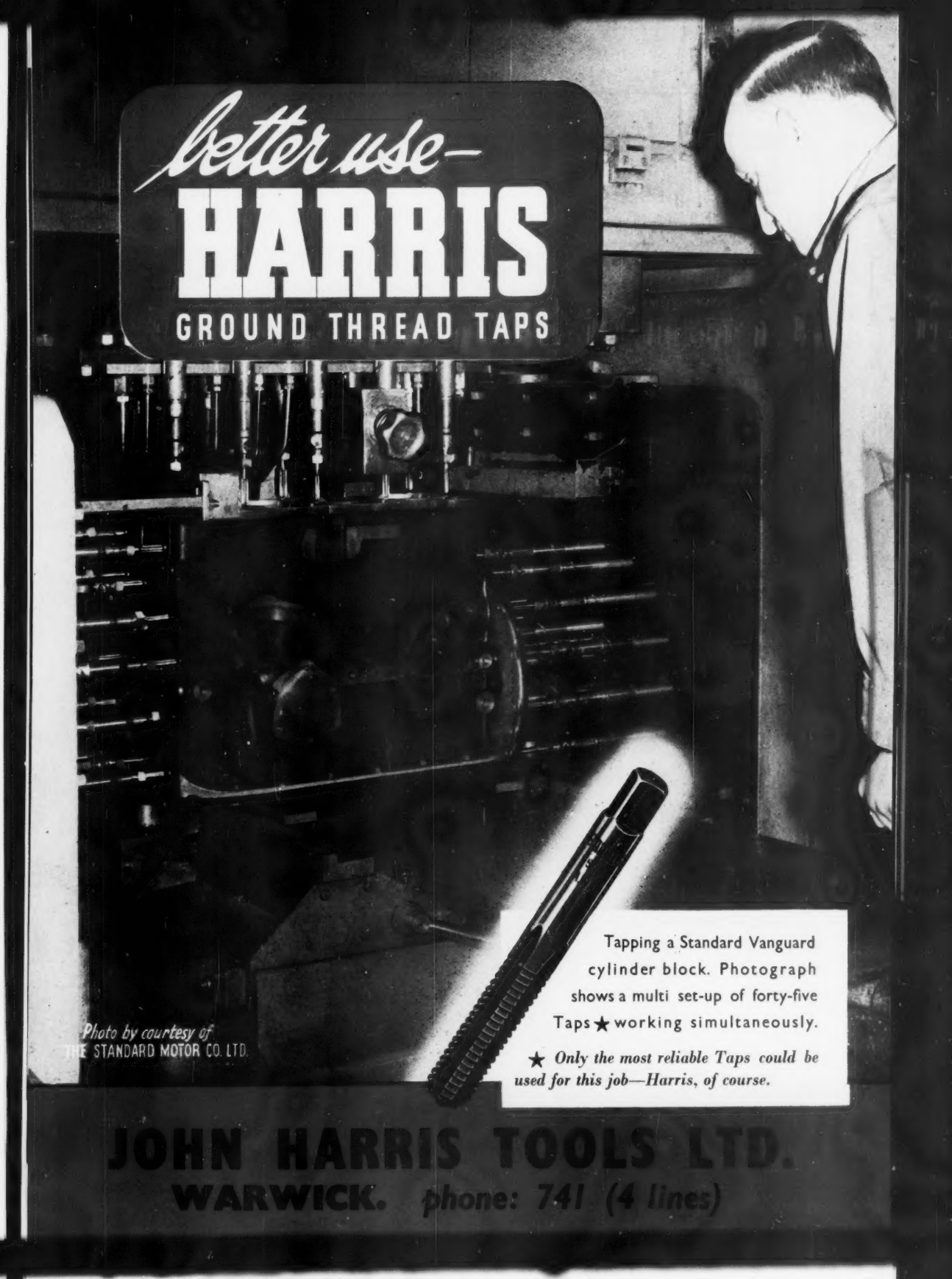

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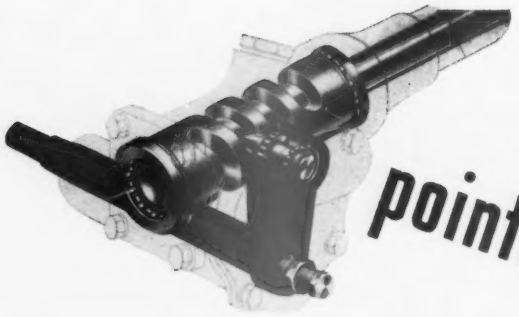

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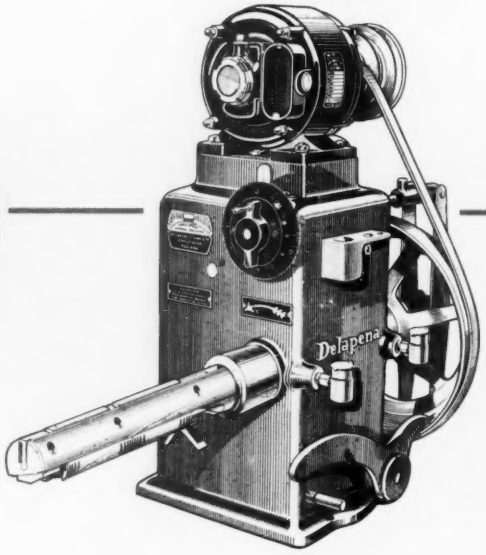

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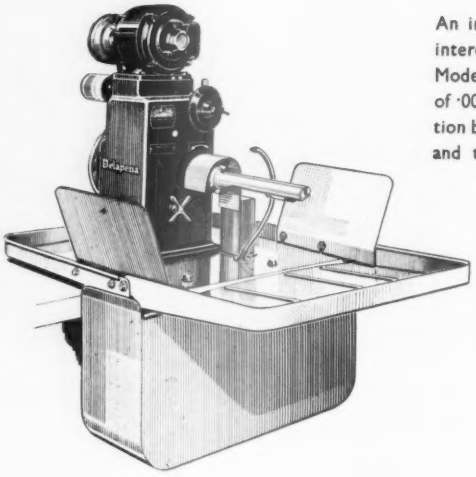
(Range : $\frac{1}{8}$" to $2\frac{3}{8}$" dia.)



An indispensable tool for all engineers who are interested in accuracy and surface finish. The Model MA Precision Honing Machine enables limits of ·0001" or better to be maintained on a production basis, using unskilled labour. Errors of ovality and taper are removed and surface finishes of 1 micro-inch are readily obtainable.

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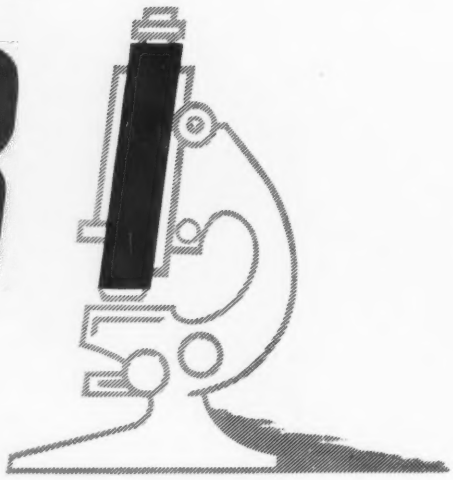

IS WATCHING OUT FOR YOU

But don't be alarmed, F.B.I. in this case stands for Ferodo Batch Investigation — and it's your *interests* that are being watched.

From every batch of Ferodo friction materials, samples are taken and ruthlessly tested for efficiency and durability. On the M.I.R.A. Track (of which Ferodo Limited are one of the largest users) the final and practical proving of the finished product takes place. All this, and the ceaseless experimental work in the Ferodo Test House, ensures that Ferodo friction materials maintain their high standard of reliability, efficiency and durability that makes them first choice for safety all over the world.

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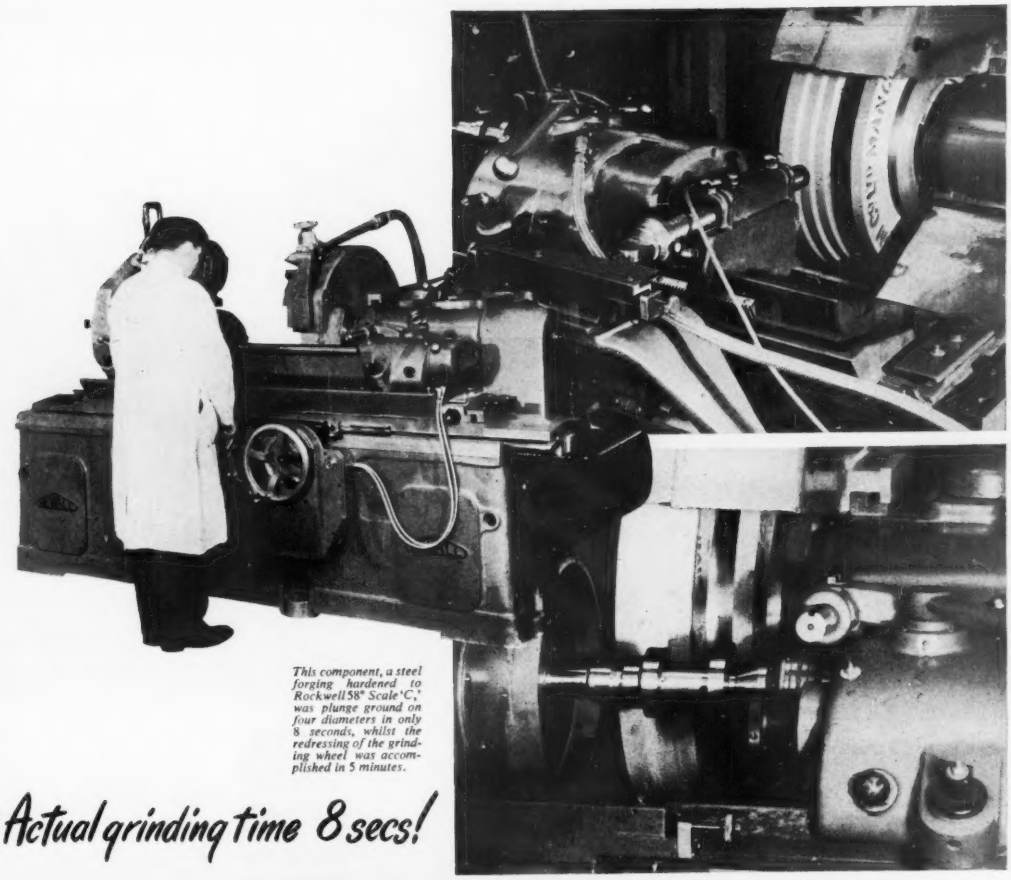
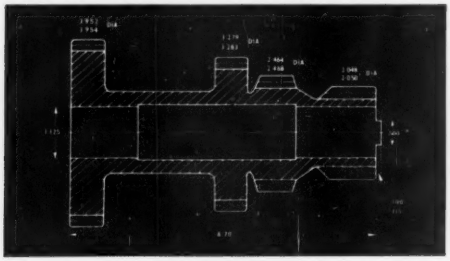


This component, a steel forging hardened to Rockwell 58° Scale 'C', was plunge ground on four diameters in only 8 seconds, whilst the redressing of the grinding wheel was accomplished in 5 minutes.

☆ Actual grinding time 8 secs!

Grind all diameters at one plunge..

In common with other leading automobile manufacturers, the Ford Motor Co., (Canada) Limited employ only the most modern production methods. Amongst their tools is this Newall 10″×24″ L.A. Grinding Machine. With this machine, all diameters of Gear Transmission Countershafts can be ground at one plunge—the actual grinding time taken being only 8 seconds. The L.A. Grinding Machine has proved to be the right tool for high and economic outputs.



◀ gear transmission countershaft

P1295

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On the Triumph Mayflower the Standard Motor Co. Ltd. have saved labour and material costs by using 168 Spire Speed Nuts per car. Spire is the name. Speed is the reason. Spire Speed Nuts make faster, easier assembly — and that means saving. But not saving at the expense of performance. Far from it. These self-locking fasteners are functionally better than the old methods they replace. Each fastener saves 50/75% on weight of materials used.

114 SNU Spire Speed Nuts are used to secure Steering Column Attachment Bracket; Door Vent Drain Trough; Instrument Plate; Radiator Toggle & Clamp; Operating Lever; Handbrake Bracket; Dash Tray Millboards; Loudspeaker Attachment; Fascia Tray Cover; Steering Column Bracing Tube Bracket; Heater Blower Bracket; Trafficator Attachment; Bonnet Support Bracket; Driving Mirror; Sun Visors; Drain Channel Door Vent; Door Fittings; Rear Quarter Fittings; Rear Bumper Valance; Accelerator Pedal Bracket.

42 SNJ Spire Speed Nuts are used to secure Radiator Shell; Steering Column Sealing Plate; Steering Column Blanking Rubber; Heater Blower Attachment Plate; Heater Blanking Piece; Bumper Valances; Heater Duct; Dash Cover Plate.

5 SNP Spire Speed Nuts are used to secure Radio Loudspeaker Board; Speedo Trip (Slave).

7 SFP Spire Speed Nuts are used to secure Mayflower Badges; Door Armrests; Accelerator Pedal Bracket (to Dash).

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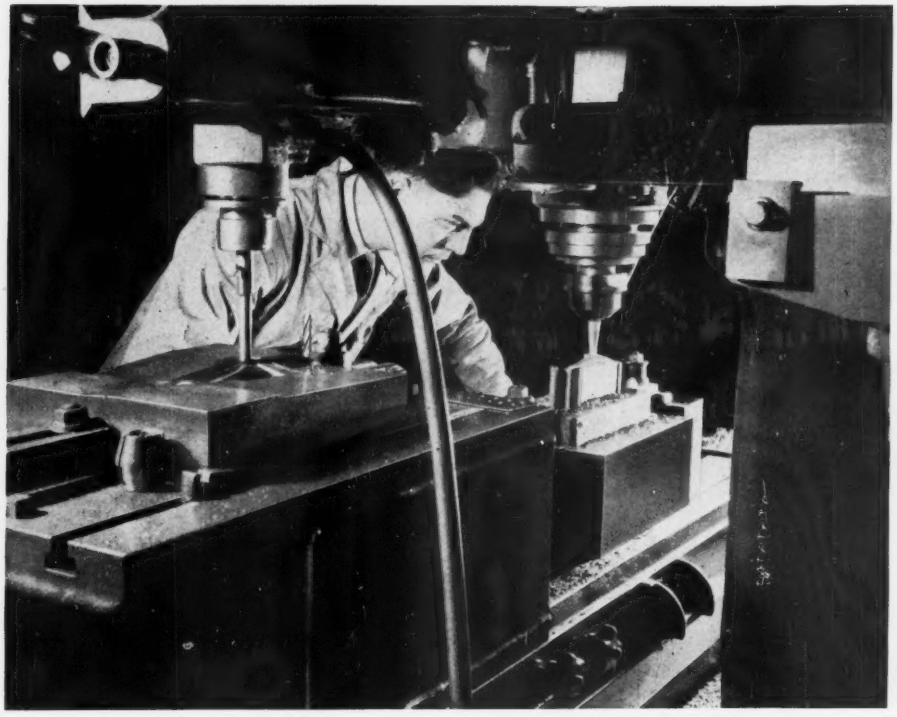

Interesting . . . but tough

Heat-resisting steels are tough and not easily deformed even at high temperatures. Dies for drop-forging the elaborate shapes of gas turbine blades have a pretty hard job of work to do. Above are dies being machined at Doncasters on a profile copying machine. The lower illustration shows the beginning of marking-out a die block for the drop forging of connecting rods.

Doncasters not only forge and make their own dies for drop forging, but supply die blocks to the drop forging trade.

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DONCASTERS ◇ 1778 D D

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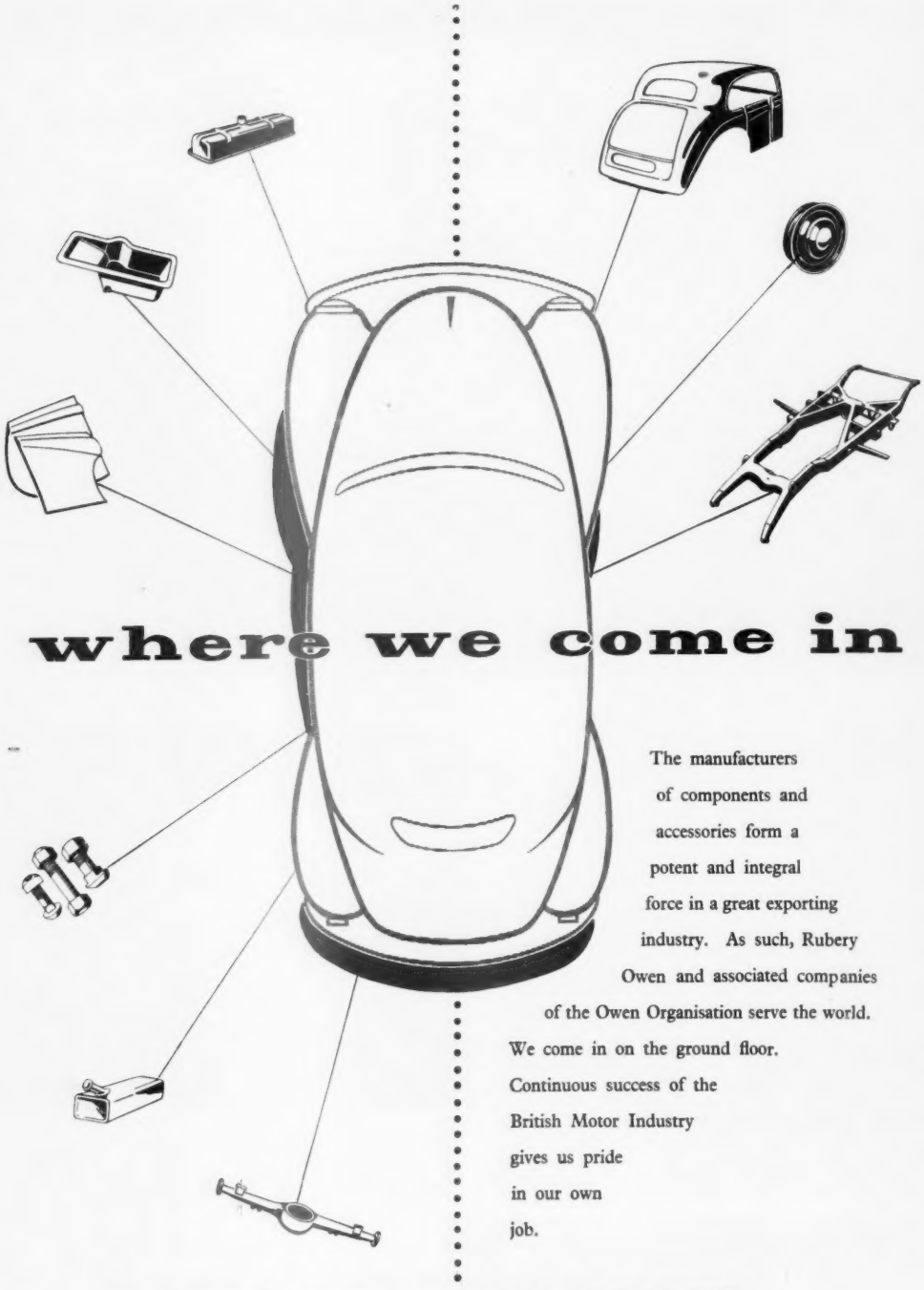

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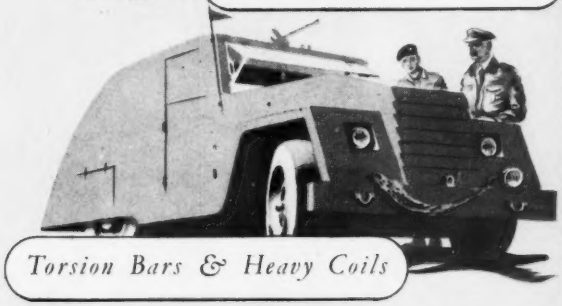

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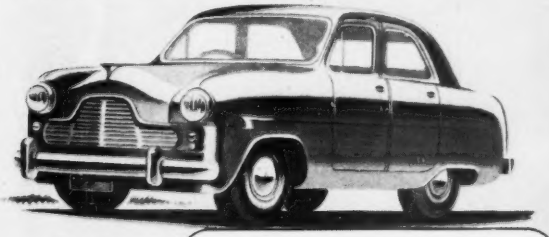

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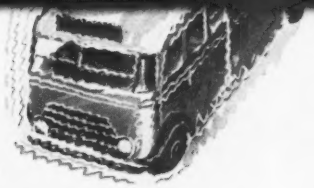

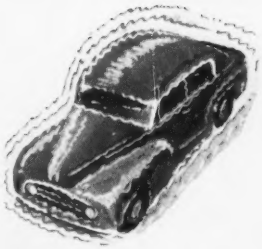

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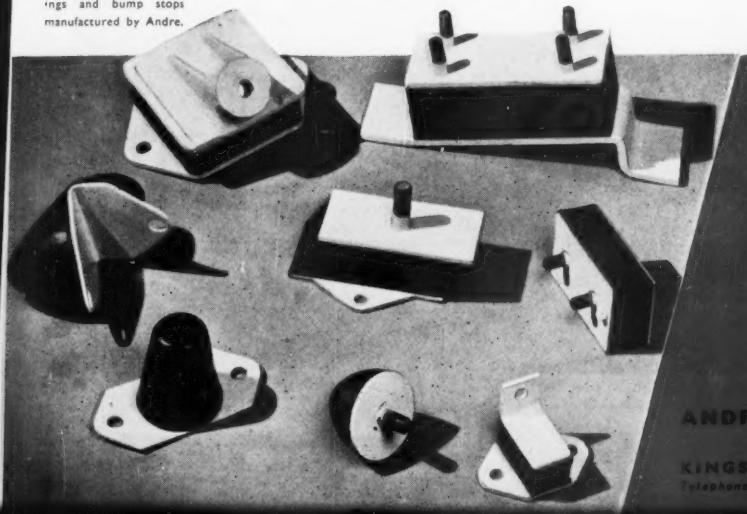

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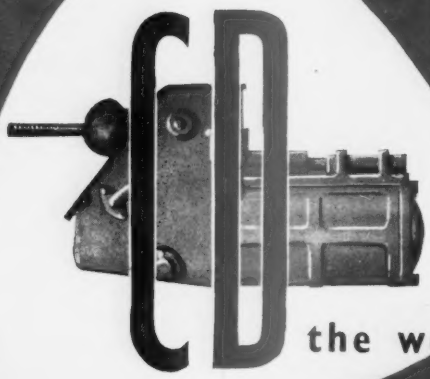

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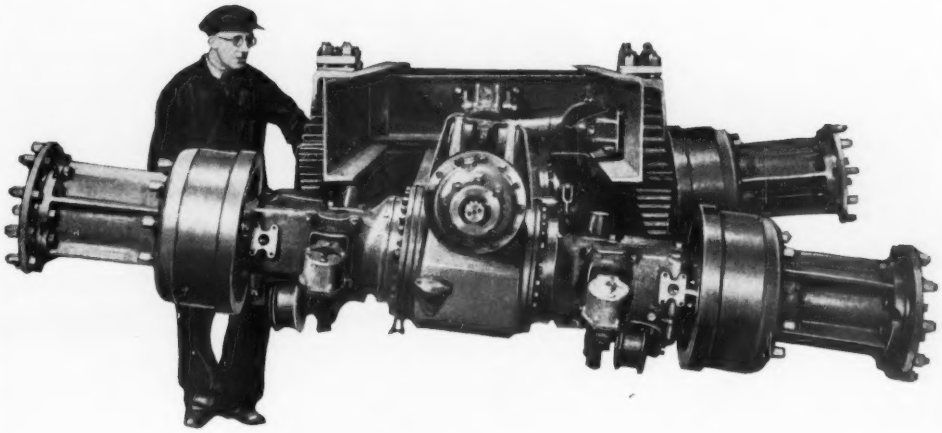

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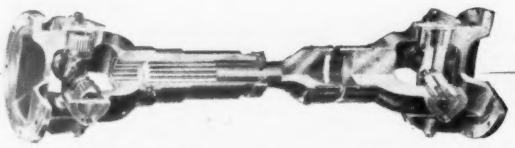

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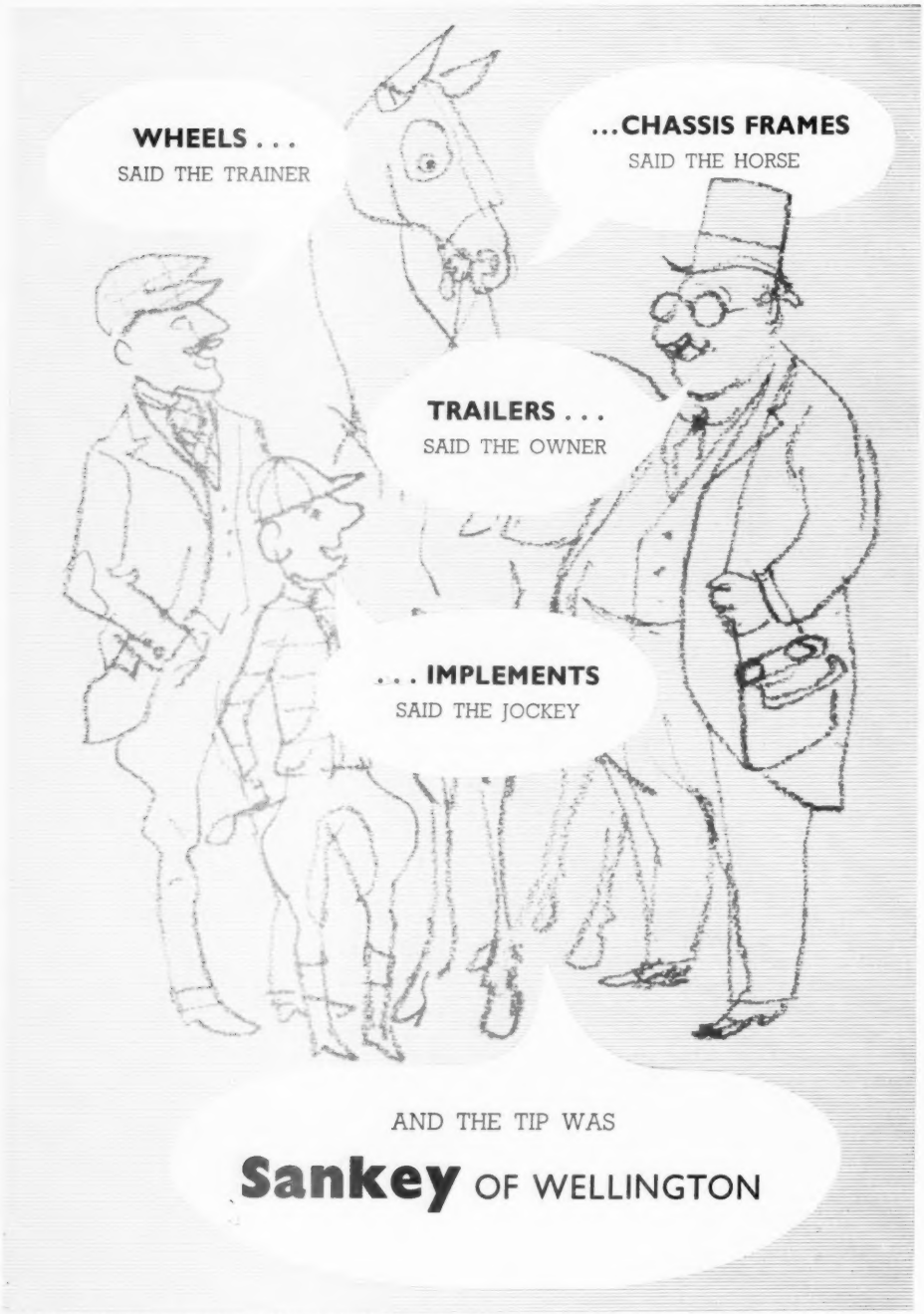

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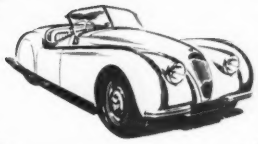

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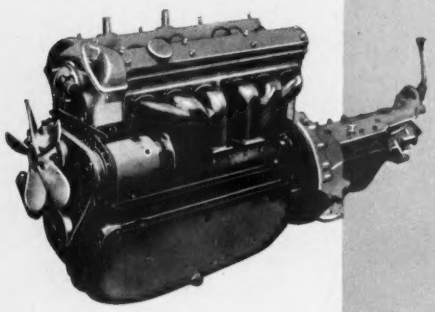

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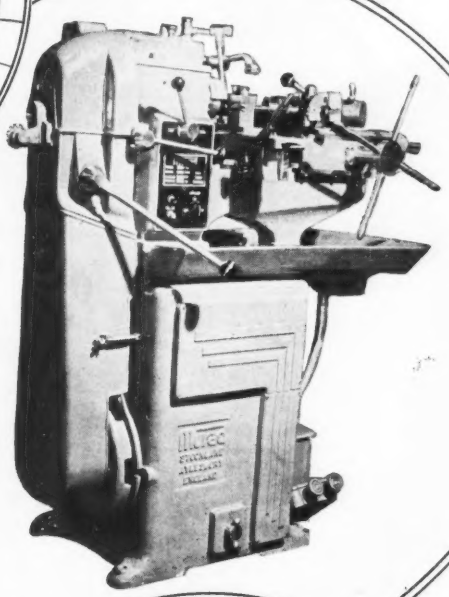

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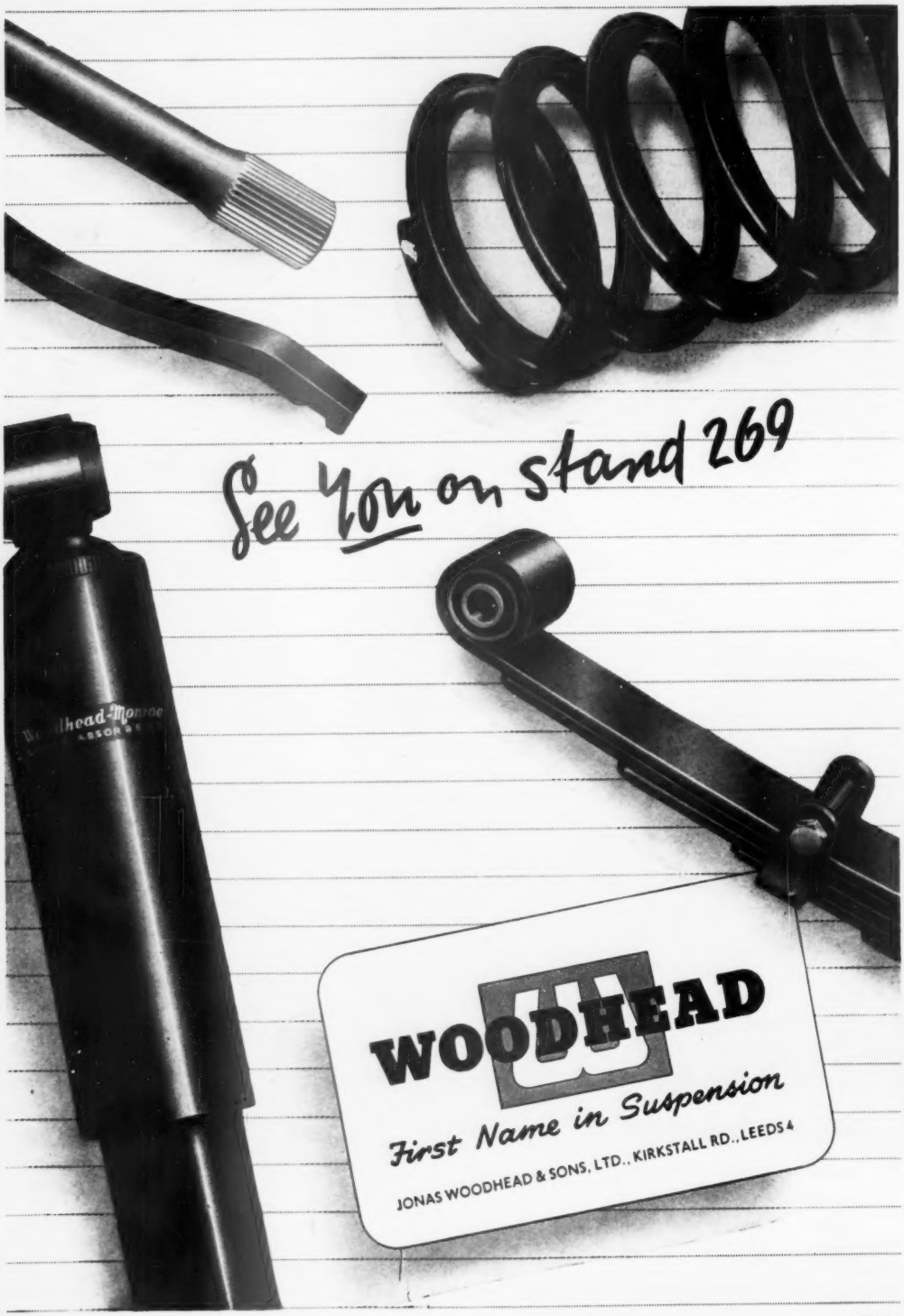
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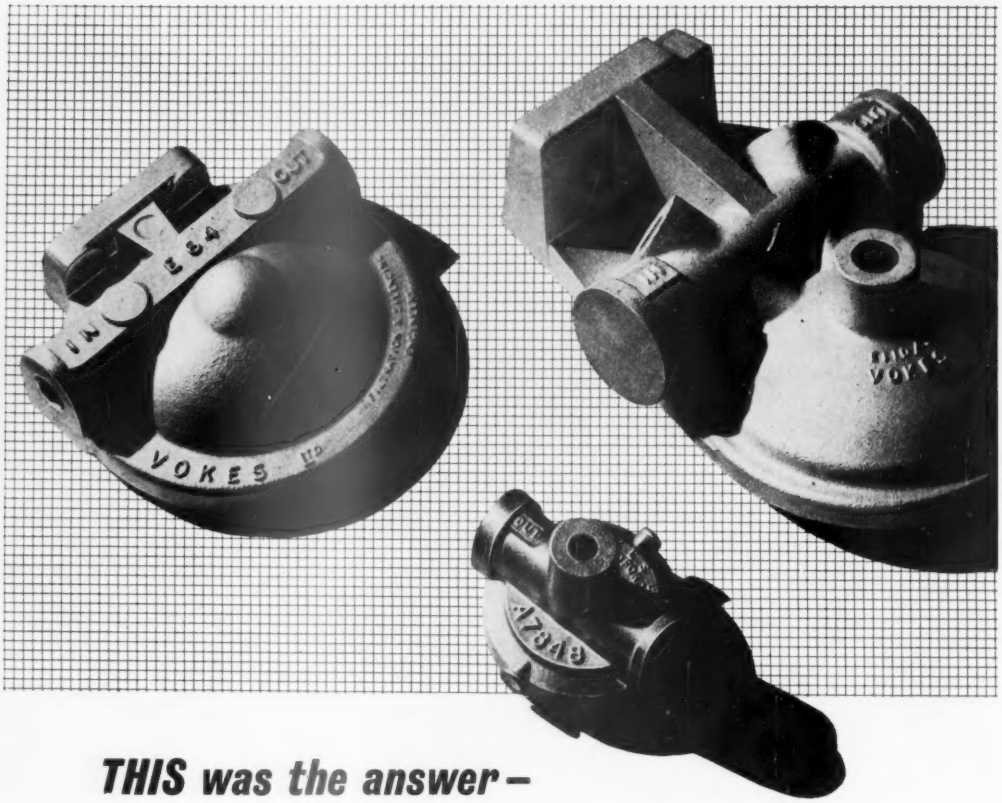
VOKES LIMITED gave us a Die Casting Problem



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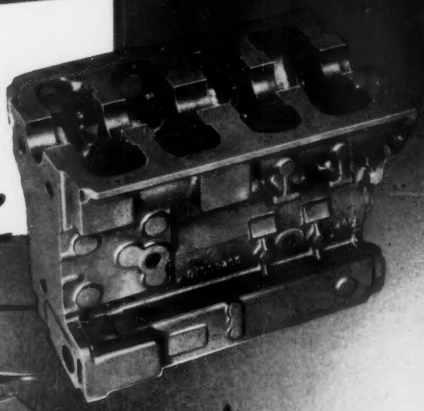

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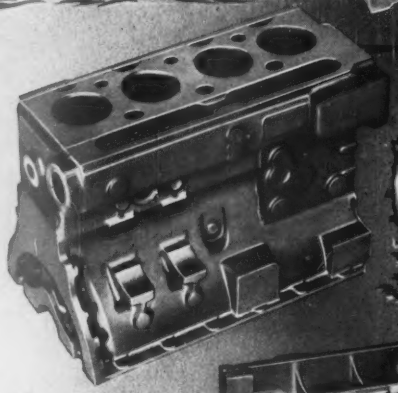

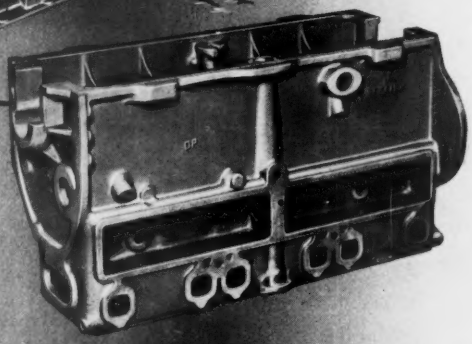

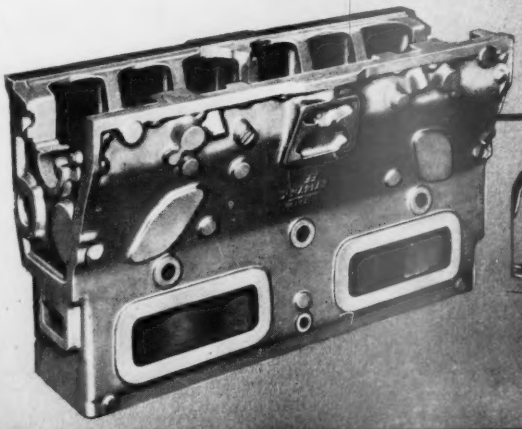

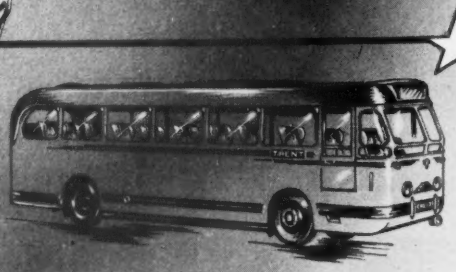

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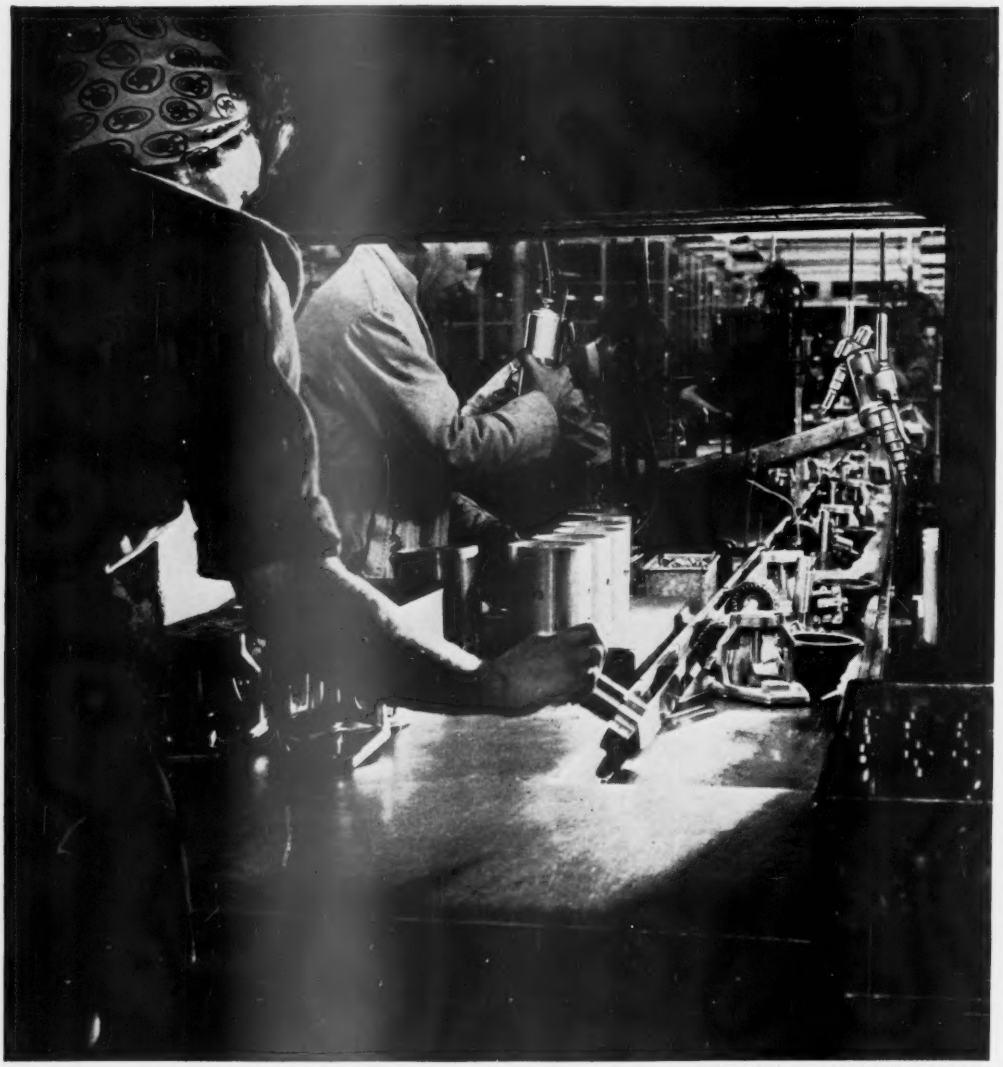

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AUTOMOBILE ENGINEER

Design, Materials, Production Methods, and Works Equipment

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The Automobile Show

THERE was much of interest but no really surprising development at the 1952 Automobile Show. Indeed, fewer completely new vehicles were exhibited than in 1951, and the new British designs were all on conventional lines. As regards both performance and price, the range of available vehicles remains substantially unaltered. Nor did the vehicles exhibited suggest that any major changes should be expected in the near future; nevertheless, although there was no tangible evidence to warrant the assumption, there is a strong feeling that during the next twelve months there will be several new and interesting developments.

It might, indeed, be said that the theme this year was detailed modifications of established designs. The modifications included slight changes in engine design to give improved performance or to simplify production; in suspension systems to give better riding, and in body design to give greater luggage accommodation.

Engines and transmissions

In engine design, the trend towards using overhead valves continued, and the percentage of engines with side valves was four less than last year. Indeed, only one new side valve engine, an American, was exhibited. This trend will undoubtedly continue, since the increased power and other liveliness obtained with overhead valves is now more widely appreciated, even by motorists who are not particularly concerned with high speed driving.

How far the claims that square, or over-square engines will give more economical running and longer life will be substantiated still remains to be seen. It is however, practically certain that, at least for the cheaper cars, any new engines that may be developed in the near future, will have approximately equal dimensions for bore and stroke.

In some respects, the most surprising development was the introduction by Rolls-Royce of a modified design of the general Motors Hydra-Matic transmission. At present this transmission can be supplied only for export vehicles. It will probably be applied mainly to cars for the American market, since the conditions in many parts of the U.S.A. lend themselves to the best possible use of an automatic transmission.

Whether the benefits to be gained from a fully automatic transmission are sufficient to warrant the extra complexity and expense involved, is still a matter of debate. The general consensus of opinion is not in favour of such devices for use in this country. Here, the conditions are generally such that the increased driving simplicity would be more than offset by the reduction in overall efficiency that seems to be inescapable when an hydromatic transmission is employed.

For this, and for European countries, there are systems which appear to have greater possibilities than the fully automatic systems used in America. It must not be forgotten that the fluid coupling, the precursor to current American designs of fully automatic transmissions, was developed and applied in this country years before similar mechanisms were developed in other countries. This year three British makes of cars incorporate a planetary self-changing gearbox that contains the essential elements of some of the American automatic transmissions. Two use it in conjunction with a fluid coupling, and the third also incorporates electrical solenoids that select the gears to be engaged.

Perhaps the most interesting transmission development exhibited was the Lockheed Manumatic control. This mechanism eliminates the use of the clutch pedal, and for gear changes, the driver has merely to move the gear lever on the steering column to effect a noiseless and shockless change. To obtain the best performance from this semi-automatic gear control, it is desirable that there should be synchromesh for the first gear as well as for other ratios, but this is not absolutely essential. For the time being at least, there appear to be more potential applications for this semi-automatic control than there are for fully automatic transmissions.

Brakes

Conventional braking systems were applied to all the vehicles exhibited at the Show. As compared with 1951, the braking systems were the same but there was a definite tendency towards the use of considerably increased friction area, and greater attention had been paid to brake cooling. Increased use is also made of the two-leading shoe brake for the front wheels.

Both major British manufacturers of brakes exhibited disc brakes. These brakes have given excellent results on sports cars, and there is little doubt that before long they will be fitted to the higher performance production cars. The greatly improved performance of post-war cars, in conjunction with the problems of brake cooling, which have been aggravated by modern bodywork design, have greatly increased the difficulties of ensuring satisfactory brake

operation. Disc brakes appear to offer a thoroughly practical solution to many braking problems.

Bodywork

The exhibits in what may be termed the luxury class proved beyond doubt that British coachbuilt bodies are still supreme. Without exception, the coachbuilt bodies were all recognizably in the British tradition, but at the same time many conformed to modern styles. Although it is perhaps invidious to pick out one of the many impressive bodies, mention must be made of the Bentley Continental with Mulliner coachwork. This body has been developed on aerodynamic lines of wind tunnel investigations. It has very pleasing lines, remarkably low drag and at the same time there is adequate passenger and luggage accommodation.

A tendency, which it is to be hoped will be carried still further, is that towards improved all-round vision. Forward vision in some models has been greatly improved by lowering the bonnet line, even though in some instances this has entailed a return to mounting the carburettor horizontally. Hitherto, vision to the rear has not received the attention that it merits, but there is an encouraging trend towards fitting larger rear lights.

The future

That more difficult times are ahead for the British automobile industry needs no stressing. Because of restrictions imposed by many governments, export markets are contracting, while the potential world output of cars is increasing. Shortage of dollars restricts the sale of American cars in most of the export markets of the world, but there is already intensified competition from Continental manufacturers.

The production figures for this country, France and Germany carry a warning that must not be disregarded. In the first half of 1950 the weekly output rate in this country was 10,150 units, whereas the combined weekly output rate for France and Germany was 8,300 units. By the second quarter of 1952, British weekly output had fallen to 8,300 units (this, because of the cuts in material allocations) but the combined French and German output had risen to 13,000 units a week. In some neutral markets, such as Holland and Switzerland, the French and German factories have already established a clear lead in sales.

To meet this competition is not going to be easy. The luxury and semi-luxury vehicles will no doubt retain their markets, so far as import restrictions allow, but in the cheaper classes there is obviously going to be very fierce competition, and it is to these classes that we must look for any major increase in our exports. A significant change in prices seems to be a necessary preliminary to increased exports, but a comparison of prices per pound kerb weight of British and Continental cars suggests that this will be difficult.

For existing models, there is no one specific that will make possible the necessary price reduction. It can be obtained only through the cumulative effect of many different factors. A good deal of standardization has already been carried out on accessories and components, but it could be carried further with benefits for both the manufacturers of these items and the car manufacturers.

Concentration of production on a smaller number of models could also effect some reduction in costs, but the possible savings through this are being greatly exaggerated in some quarters. There is not the slightest doubt that as far as the large quantity producers are concerned, the factor that at present is having the most adverse effect on prices is that production capacity is far from fully employed. This of course is due to shortage of materials and not to factory inefficiency. Any reduction in machine utilization has a more than proportionate effect on unit costs. It is therefore of great importance both to the industry and the country that production capacity be used to the full.

If car sales are to be extended to lower income groups (a necessity if production potential is to be fully employed) there is need for a radical change in outlook on design. For many years there has been a tendency towards incorporating more and more refinements in even the cheapest British cars. The time seems to have come for a reversal of this tendency. For example, with an engine developing adequate torque, a three-speed gearbox should give reasonable performance.

As yet, British manufacturers have not thought fit to produce anything comparable with the very small French economy cars. Whether they ought to, or will, is still a matter of debate. Such a vehicle with a bare minimum of equipment and a low maximum speed, but with a very low petrol consumption would probably not make too wide an appeal in this country at the outset, since its performance would undoubtedly be compared with that of existing small cars. At the same time, export possibilities would probably be confined to markets subject to severe import restrictions and already served by existing makes. Nevertheless, the possibilities of a small economy car should be seriously considered.

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EARLS COURT EXHIBITION

A Review of Design Trends

ENGINES

General Rationalization of Design

SO far as engines are concerned there was but little difference between the 1951 and 1952 Motor Shows. There were only three new British engines, and two of these are already well known. That the changes were so slight is not surprising. Existing power units are giving very good service, and it is difficult to see how they could be improved in any very marked degree. Yet, to justify the heavy tooling charges that are inevitably incurred when a new engine is to be produced, an appreciable improvement is necessary.

Competition for sales in the automobile world is already keen and it will undoubtedly be very much keener in the near future. It is therefore to be hoped that any efforts that are now being carried out towards developing improved power units will before long be ready for practical application. There are two principal lines of development. One directed towards the development of designs that can be produced more cheaply, and the other to developing units that will be more economical to run.

During the past year, normal development work has been going on continuously on current designs and minor modifications have been made here and there to simplify production, remedy slight defects, and improve performance. Manufacturers are still having to use substitute alloy steels for many mechanical components, although the supply situation in this respect has eased a little.

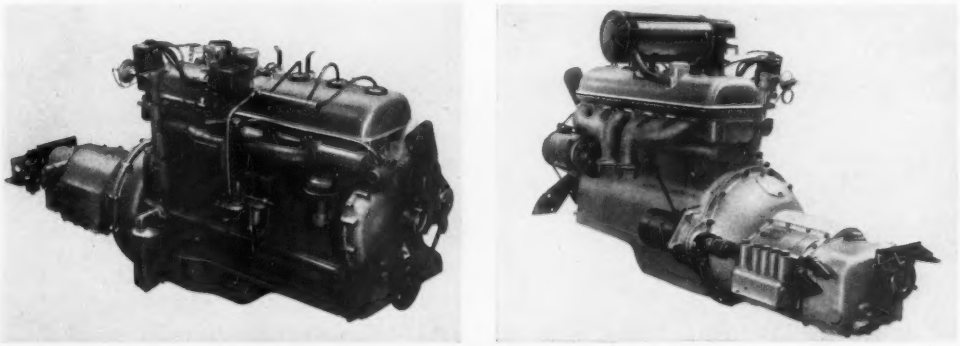
A few months ago, the Vauxhall Square engines of 1½ litres and 2¼ litres capacity were introduced; they were described fully in the September issue of *Automobile Engineer*. Apart from those, the only completely new power unit of British manufacture to be announced has been the 3½-litre Armstrong Siddeley Sapphire. The engines of these two manufacturers are in very different categories and, because an isolated example cannot be truly indicative of current general practice, it is difficult to detect any very positive trends in design.

However, statistics show that there are now only 26 per cent of side valve units in production, in all countries, as compared with 31 per cent last year. The latest change in this direction has been made by Morris Motors Ltd., who now fit the British Motor Corporation 803 c.c. O.H.V. engine in the Minor. Several manufacturers have made small increases in the compression ratio of their engines, but in many cases this measure has been one of several modifications to make a normal production engine suitable for sports cars.

Opinions still seem to be divided on the subject of oil filtration. Some manufacturers are employing the by-pass system while others favour the full flow filter. A further alternative seems likely to become available, and that is the centrifuge type of filter at present manufactured by Glacier Metal Co. Ltd. Although the unit, in its present form, is probably only suitable for commercial vehicles, there is little doubt that a much less expensive version can be made if it is demanded for passenger cars.

So far as cooling systems are concerned, ther are two features that are becoming increasingly popular. One is the employment of jet tubes in the cylinder head water jackets. These tubes have holes punched in their walls to direct water from the pump on to those parts where it is particularly needed, that is, around the exhaust valve seats and ports, and spark plug bosses. This is obviously a sound practice, since in order to maintain as even a temperature distribution as possible, it is important to take more heat from these parts than from the cooler areas of the cylinders and combustion chambers. An even temperature distribution is desirable in order to reduce the possibility of distortion, as well as to obviate the danger of pinking and rough running generally.

The other feature that is gaining in popularity is the use of pressurized cooling systems. Any measure that reduces the size of the radiator is often useful, because in many installations a high radiator makes access to the engine more difficult. Moreover, modern styles seem to be tending to restrict the cooling air supply more and more, and there is a constant demand for weight reduction. There is a factor not often taken into consideration in designing pressurized systems, and that is the increased possibility that leaks may develop. So far, little has been heard of complaints on this subject, but as vehicles incorporating this feature become older, it may be that more careful maintenance will be needed than with the unpressurized systems.



Right and left side views of Armstrong Siddeley Sapphire power unit. The distributor is mounted on a turret casting for accessibility. A single cover encloses the two overhead valve rocker shafts

On the Fiat V8 cylinder head the casting sections around valve seats and ports are unusually thick

Each cylinder head of the Fiat V8 has two integral brackets supporting the carburettors, and incorporating passages leading to siamesed ports

So far as the Armstrong Siddeley Sapphire engine is concerned, much credit is due to the designers for its many original features. The general layout is one that must inevitably result in efficient operation. The engine is a six-cylinder unit with a bore and stroke of 90 mm × 90 mm. Thus it conforms with the modern trend, in that it is a square engine. Many advantages are claimed for this arrangement, but whether all of them are fully justified is difficult to decide. However, it cannot be disputed that, with a relatively large cylinder bore, the valve ports can be larger, to improve volumetric efficiency; and better spaced, to give adequate support for the valve seats, as well as to enable generous cooling passages to be incorporated around them. Another advantage of square, or nearly square dimensions is that big end bearings of larger area may be employed, and the short throw tends to give greater rigidity to crankshafts.

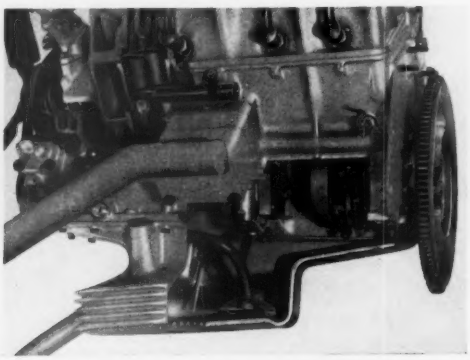
The swept volume is 3,435 c.c. A maximum b.h.p. of 120 is obtained at 4,200 r.p.m., when the mean piston speed is 2,480 ft/min. This gives a figure of 2·03 b.h.p/in^2 piston area, and 35 b.h.p/litre. The maximum torque is 165 lb/ft at 2,000 r.p.m. and the b.m.e.p. at the same speed is 120 lb/in^2. These performance figures are good considering that they are obtained with the relatively low compression ratio of 6·5 : 1. The brake specific fuel consumption is 0·54 pt/b.h.p/hr at 2,000-3,000 r.p.m.

Without the gearbox and clutch, the engine weighs 587 lb. It is installed at an angle of 2½ deg (vehicle fully laden) and a three-point Metalastik mounting system is employed. The single point at the front is a tubular, rubber-bushed unit, with its axis a few inches below, and parallel to, the axis of the fan. At the back, two rubber cone mountings are positioned, 7¼ in apart, one on each side of the rear of the gearbox. Separate rubber pads are incorporated with these two mountings to provide an adjustable torque reaction system.

The general layout of the engine is very sound. A one-piece cylinder block and crankcase of close-grained cast iron with a fairly high chromium content is employed. In order to obtain the maximum possible stiffness, the cylinders are cast integrally with the block. The cylinder wall thickness is 0·225 in, and the bores are finished by honing, the surface roughness being 25 micro inches. Two transverse webs carry the intermediate journal bearings of the crankshaft, and the crankcase walls extend down to a level well below these bearings to provide a flat joint face with the sump.

A fully balanced, four-bearing, forged crankshaft of En 9T is fitted. The diameter of the journal bearings is 2¾ in, and all except the rear one are 1¾ in long. The rear bearing is 1⅞ in long, and, on each side of it, Vandervell steel-backed white metal washers take the thrust. The bearing shells are also the white metal steel-backed type supplied by Vandervell Products Ltd. At the tail end, an oil return scroll is machined on the shaft. It operates in conjunction with an integral oil thrower ring. A conventional rubber seal is employed at the front.

The V8 engine installation in the Fiat sports coupé



A flange, integral with the crankpin, spaces each pair of big-end bearings on the V8 Fiat

The connecting rods are made of En 8Q. They have a centre-to-centre length of 6·5 in, which gives a connecting rod length/stroke ratio of 1·83 : 1. The bearing caps seat at an angle of 45 deg, so that the rods may be withdrawn through the cylinder bores, and the caps are located by dowel tubes around their bolts. Vandervell steel-backed white metal bearing shells are carried in the big ends, the diameter of the crankpins being 2¼ in. A Clevite small end bush, the internal diameter of which is 0·875 in, is employed.

Bricovmo, Lo-Ex pistons are fitted. They are tin plated to assist running-in. Two compression rings, and one Maxigroove oil control ring, are positioned above the gudgeon pin. The top ring is chromium plated to reduce wear.

At the front of the engine, a Duplex roller chain of ½ in pitch transmits the drive to the half speed wheel. Chain tension is maintained by an eccentrically mounted jockey sprocket, which may be adjusted from outside the cover. No provision is made for fine adjustment of the timing.

The four-bearing camshaft, of En 32, is carried high up on the right-hand side of the cylinder block. Axial location is effected by a gunmetal thrust plate at the front end. The piston-type tappets each carry a steel ball, and the push rods are cup-ended so that, at their lower end, they seat on the ball, and, at the top, on the spherical ended tappet adjusting screw. The inlet and exhaust rods are inclined at different angles because two rocker shafts are employed, one on the inlet and the other on the exhaust side. This means that the push rods are necessarily of different lengths. However, the masses of the valve operating systems are approximately equalized by using the shorter rods for the inlet valves. As a result, it has been possible to fit springs common to all valves. Two springs are employed with each valve. This layout is much less expensive than the alternatives such as the twin camshaft designs or the more complicated rocker arrangements that are sometimes employed.

Hemispherical combustion chambers are incorporated in the cast iron cylinder head. The valves are inclined in transverse planes at an included angle of about 70 deg; the exhaust ports, the throat diameter of which is 1·35 in, are on the left, and the inlets, with a 1·45 in diameter throat, are on the right. This layout gives an exceptionally straight port arrangement, and permits the incorporation of generous cooling passages. A lift of 0·3588 in at the inlet, and 0·3075 in at the exhaust valve is employed, and the rocker ratios are respectively 1·28 : 1 and 1·1 : 1. The timing, with the hot tappet clearances set at 0·006 in is as follows:

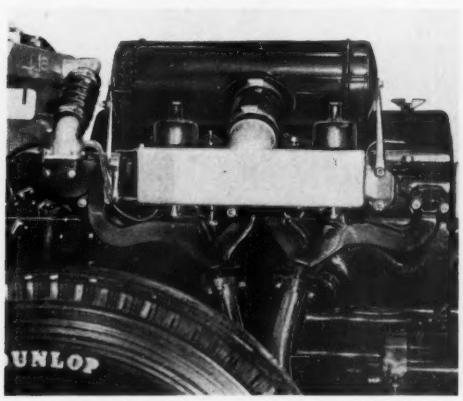
Inlet opens	..	8 deg B.T.D.C.
Inlet closes	..	62 deg A.B.D.C.
Exhaust opens		46 deg B.B.D.C.
Exhaust closes		18 deg A.T.D.C.

Unlike many engines with twin rocker shafts, a single rocker cover is fitted. This somewhat simplifies the holding down arrangements, and eliminates a considerable length of joint face. Because this makes the rocker cover rather large it is double skinned, and has felt sandwiched between the two shells to reduce resonance and noise. It has been necessary with this layout to position the plugs in tubes let into the top of the rocker cover. The lower ends of the tubes are thimble-shaped, and seat under the spark plugs, while the upper ends are sealed by a rubber grommet positioned around the tube and carried on the rocker cover. This arrangement is considered by the manufacturers to be satisfactory, as the plugs are positively sealed from the oil in the tappet cover, and a plastics cap over the top end of each tube prevents foreign matter from entering.

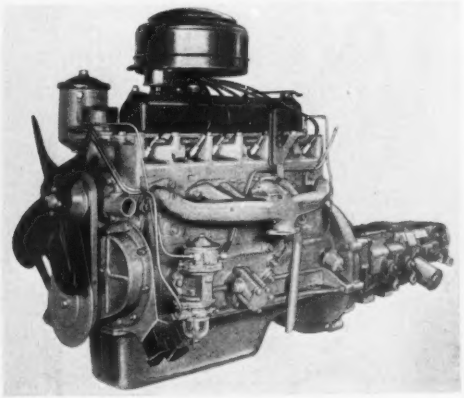
In order to reduce the adverse effects of thermal expansion, the cast iron exhaust manifold is in two pieces bolted to the Y-shaped end of the exhaust pipe. On the other side, the induction system is somewhat unusual. A normal four-port cast aluminium manifold is bolted on a gallery pipe extending the length of, and cast integrally with, the cylinder head. The manifold branches feed the mixture in at such a position as to give a flow somewhat similar to that obtained with siamesed inlet ports. It has not been practicable, of course, to employ an exhaust heated hot-spot in the induction system, so the manifold is water-jacketed at its junction with the riser pipe. A D.A.A. 36 Stromberg down-draught carburettor, with a 36 mm choke, is bolted on the riser pipes.

The cooling system is the normal pump, fan and thermostat arrangement, and a jet tube is carried in the cylinder head. A Coventry, four-row, gilled brass tube radiator is employed. The lubrication system is conventional, and the normal pressure of 40 lb/in² is maintained by a submerged, Hobourn Eaton pump. An A.C. or Purolator, full-flow filter is incorporated in the circuit.

Another interesting new engine was that installed in the attractive Fiat V8 sports coupé. It is a remarkably compact unit, having an overall depth of approximately 2 ft 3 in. The cylinders are inclined at an included angle of 70 deg, and their bore and stroke is 72 mm × 71·3 mm, giving a swept volume of 1,996 c.c. At 6,000 r.p.m., the maximum b.h.p. of 110 is developed. This gives a figure of 55 b.h.p/litre, and 2·18 b.h.p/in² piston area. The compression ratio is 8·5 : 1. A cast aluminium cylinder block and crankcase unit is employed. Its walls extend down approximately to the level of the lowest point on the path swept by the crankwebs, so that it is below the level of the main journal caps. The rear oil seal takes the form of a casting positioned around the rear of the crankshaft and bolted to the crankcase end wall. At the front, the cast aluminium sump extends forward, under No. 1 main bearing and is bolted to the lower edge of the cast aluminium timing cover. Horizontal finning is em-



A two-piece exhaust manifold is now fitted to the Alvis 3-litre engine



On the Willys-Overland Hurricane engine, the front mounting is designed to give fore and aft stability

ployed at the front and around the sides of the sump. Cooling the sump in this manner is always a difficult problem; horizontal fins tend to become clogged with dirt, but vertical fins, if incorporated beneath the sump, take up valuable ground clearance. In this case, however, the base of the sump is corrugated, so that not only is it less likely to become fouled, but also the base of the corrugations are not so low as fins, to give the same cooling effect, would be.

On each side of the crankcase, there is an unusually large rubber sandwich mounting. It is positioned approximately mid-way between the two ends of the cylinder block, so that it will absorb all the vibratory forces due to the crankshaft and reciprocating elements. This is a good feature because the rear mountings, on the back of the gearbox, support only part of the weight of the clutch and gearbox unit, and there is less tendency for vibration and noise to be transmitted through these mountings into the body.

Flanges little more than half-way down the cylinder liners seat on copper washers on shoulders cast in the cylinder block. Horizontal webs around these seats ensure that there is adequate rigidity, and the webs are cored out, so that coolant may pass through them from the upper part to the lower part of the jacket. Thus the upper portion, or the flame-swept part of the liners, is wet, while below, they are in effect dry liners. The top ends of the liners bear against the copper and asbestos gasket under the cylinder head.

A three-bearing crankshaft is employed. The connecting rods are mounted in pairs on the crank pins, and the arrangement is somewhat unusual in that a flange is formed integrally around each pin so as to separate the big ends. This makes the big end bearings rather short, their length being about $\frac{21}{32}$ in. A transverse slot is machined transversely at the top end of the rods to assist the splash lubrication of the fully floating gudgeon pins.

The aluminium pistons carry two compression rings, and one slotted oil control ring above the gudgeon pin. A crimped expander spring is positioned in the ring groove under the oil control ring. The piston crown is shaped to fit into the wedge-shaped combustion chamber, and to clear the valve heads.

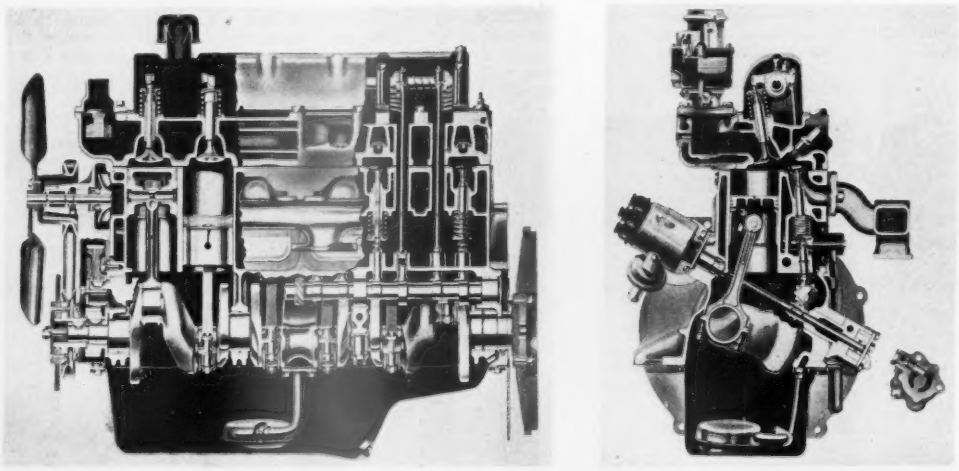
Another unconventional feature of this engine is the layout of the front end. All the auxiliary drives are taken from the timing gear cover. A rather long and slender extension on the front of the crankshaft is supported at its front end in two ball bearings separated by a distance tube, and housed in a casting bolted to the crankcase front wall. The outer race of the rear of the two bearings is located between two circlips in grooves in the casting. Behind the rear ball bearing is a spiral gear which meshes with a second one, the axis of which is horizontal and at right angles to the first gear. The second gear is carried on a spindle in bushes in the casting, and it is connected, by an internally-splined sleeve-coupling, to the short driving spindle of the gear-type oil pump which is mounted on the left-hand side of the crankcase wall.

A noteworthy feature of the pump is that its driving gear is of steel, and the driven gear is bronze. Moreover, helical teeth are employed. This will, no doubt, eliminate any tendency to hydraulic knocking or other noises, because there is no possibility that oil will be trapped between the teeth.

Immediately behind the spiral gear on the crankshaft is a shoulder round which is carried the sprocket for the Duplex roller chain drive to the half-speed wheel. This sprocket is held in position by a ring nut. A nut on the front end of the crankshaft extension pulls the front drive assembly up against the shoulder. This assembly comprises the spiral gear, the two ball bearings, and their distance tube, and in front of them the fan belt pulley and another distance tube.

A single camshaft is mounted in the crankcase, below the base of the V between the two cylinder blocks. At its extreme front end, there is an eccentric on which bears a long lever-type follower which operates the fuel pump. This pump is mounted on the left of the crankcase immediately in front of the cylinder block. Between the eccentric and the half-speed wheel there is a spiral gear. Two drives are taken from this gear, one from each side. The drive spindles are parallel and inclined to the right from the vertical. One drives the distributor, mounted in front of the right-hand block; and the other, to the left of the first, carries the end of the flexible drive cable for the engine speed indicator.

Piston-type tappets carry the spherical ends of the push rods. The rods for the inlet valves are tubular, and those for the exhaust valves solid. This is to balance the relative masses of the operating mechanisms so that the springs are common to all valves. Single springs are employed. The cast iron guides are in line, and only a few degrees from the vertical, in the cast aluminium cylinder heads. Valve seat inserts are fitted, and the section around the ports is unusually thick. However, cooling may well be adequate because of the better conductivity of aluminium as compared with steel. In order to avoid distortion, thick sections are desirable in aluminium heads, particularly around the valve seats. The inlet ports are directed towards the inside of the V, and the



Longitudinal and transverse sections of Willys-Overland Hurricane engine. The induction manifold is integral with the cylinder head, and overhead inlet valves and side exhaust valves are employed

exhausts to the outside. A noteworthy feature is that the cylinder numbers are marked plainly beneath each spark plug boss.

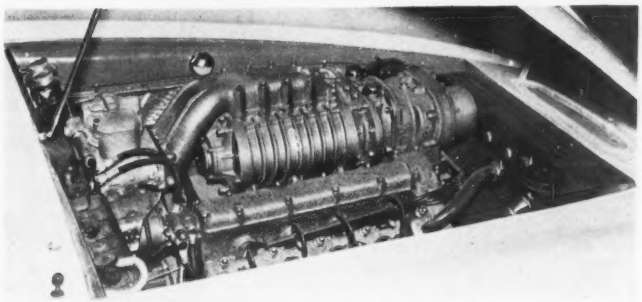
Two twin choke Weber carburettors are mounted on four brackets cast in pairs integrally with the cylinder head units. These brackets incorporate the inlet ports in such a manner that each lines up with one of the chokes of the carburettors, and serves a pair of cylinders. Presumably the alignment of the ports and joint faces calls for some skill when both the cylinder heads and the carburettors are being fitted. However, a small amount of misalignment of the joint faces might be taken up by the insulating block between them and the carburettors.

A breather pipe rests horizontally in the base of the V. It is connected at its front end to a banjo union screwed into the crankcase, and is plugged at its rear end. A small diameter stack pipe is welded to the top of the breather pipe, and is connected to the distributor box on top of the carburettors. Two more stack pipes are connected to the distributor box, one from each rocker cover.

A triangulated V-belt arrangement drives the dynamo on the right, and the water pump bolted to the top of the cast aluminium timing cover. An uncommon method of mounting the dynamo is employed. It is pivoted at the bottom in the usual manner, so that the V-belt tension may be adjusted, but the slotted adjusting bar lays flat on top of the cylindrical dynamo casing to which it is secured by a stud and nut. The other end of the bar is bent to form a lug, which is similarly secured flat against the crankcase.

A multi-vane water pump rotor is employed. The circulation from the pump is through pipes to the front end of each block. From here the coolant flow is directed by a jet tube over the hot parts of the head on the exhaust side. The outlets to the thermostat and radiator are situated at the front, on the inlet side, on top of each head.

Among the many American exhibits was the Willys-Overland Aero series of vehicles with the Hurricane six-cylinder engines. The bore and stroke are respectively $3\frac{1}{8}$ in and $3\frac{1}{2}$ in, giving a swept volume of 161 in^3, 2,630 c.c., and a compression ratio of 7·6:1. At 4,200 r.p.m., 90 b.h.p. is developed. This gives a b.h.p/litre of 34·3 and a b.h.p/in^2 piston area of 1·95.



A Roots-type blower may be fitted to the engine of the Pegaso Berlinette sports coupé

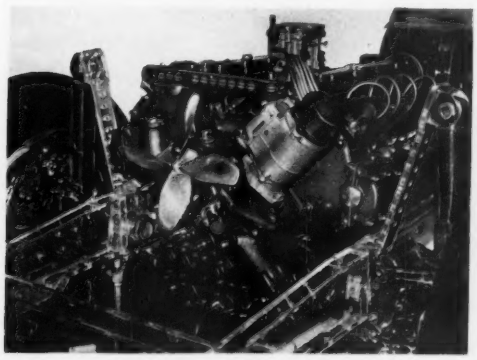
The cylinders are cast integrally with the cylinder-block and crankcase, and are siamesed in pairs. At the base, the crankcase walls extend to a level below the journal bearing caps. The front seal is formed by the joint between the sump and a flange turned forward on the pressed steel timing cover, and at the back, the sump is bolted to the flat rearward extension of the journal bearing cap.

A fully-balanced four-bearing crankshaft is fitted. The oil retaining devices at the tail end are an oil thrower ring machined on the shaft and, behind this, a gland ring. A forward extension of the crankshaft carries the spur gear driving the half-speed wheel, and the boss for the fan belt pulley and crankshaft vibration damper. Two Woodruff keys furnish the drive.

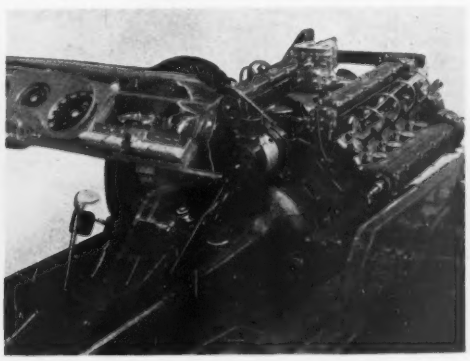
The webs of the H-section connecting rods are each slotted on their axis at their upper end, the slot extending into the small end; a pinch bolt secures the gudgeon pin. The pinch. bolt engages in a groove on the periphery of the pin to give positive axial location. Despite the fact that the big end is split at right angles to the axis of the rod, it is just small enough to be withdrawn through the cylinder bore. Flat-topped, T-slotted, aluminium pistons are employed. They have two compression rings, and one oil control ring above the gudgeon pin.

On the left, a four-bearing camshaft is carried in the crankcase, at a level just below the bottom of the cylinder skirts. Machined mid-way between its two ends is a spiral gear meshing with another which is pinned on the upper end of the oil pump transverse inclined drive spindle. The boss of the driven gear overhangs the end of the spindle so as to form a sleeve in which the end of the distributor drive is carried. Both spindles are in line in a transverse plane, the tongued end of the upper one engaging in the slotted end of the lower one to furnish the drive. The pump is bolted low on the left of the crankcase wall, and the distributor high on the right. Near the front end of the camshaft, an eccentric actuates the fuel pump.

Hardened, cup-shaped inserts in the mushroom-type tappets seat the spherical ends of the push rods operating the overhead inlet valves. Side valve exhausts are carried in the left of the cylinder block, and adjusting screws are mounted in their tappets. With



A remarkably complex front cover arrangement is employed on the Pegaso



Three drives are taken from the rear ends of the Pegaso camshafts. They are, from left to right: dynamo, fuel pump, engine speed indicator

this F-head arrangement, the choice of valve port sizes is almost unrestricted, and it is possible to provide exceptionally large cooling passages around them. The inlet manifold is cast integrally on the right-hand side of the cylinder head. It incorporates what appears to be an unnecessarily abrupt right-angle bend directed up to the Carter YF downdraught carburettor. However, this has apparently been done to form a hot-spot, as the lower portion of the right-angle is water-jacketed. A conventional rotor-type water pump is bolted to the front of the cylinder block so that the water first circulates past the exhaust ports, and then passes up into the head. The water outlet and thermostat is positioned at the front on top of the head.

Empresa Nacional de Autocamiones, S.A., are well known throughout the world for their diesel-engined coaches and trucks, which are of particularly interesting design. They have now developed a high performance sports car called the Pegaso, of which there are several variants both as regards coachwork and engines. Although the 90 deg V8, 2½ litre power units are all basically the same, they may be fitted with different carburation and induction systems. Moreover, there is an alternative 2·8 litre engine, having a slightly larger bore. The larger unit is for the heavier and more luxuriously appointed saloon versions of the car.

The principal particulars of the smaller engine, the 102 B/2·5, are as follows. Nearly square cylinder dimensions have been adopted; they are 75 mm bore by 70 mm stroke, which gives a swept volume of 2,472 c.c. There is a choice of compression ratios, the available range being 8 : 1, 8·5 : 1 or 9 : 1. A Weber 36 mm twin choke, downdraught carburettor is fitted. As an alternative, four downdraught units may be employed. With this installation the power developed is slightly more than 165 b.h.p. at 6,500 r.p.m., and the maximum torque 138 lb-ft at 3,900 r.p.m. Ignition is by coil and distributor, with 14 mm plugs or, if required, a Bosche magneto can be fitted.

A dry sump lubrication system has been adopted, the capacity of the tank being about 26½ pints. The oil recommended is S.A.E.30. A conventional pressurized cooling system is incorporated. It has a capacity of about 31½ pints. The cast aluminium fan is mounted in front of the centrifugal pump. An exceptionally large radiator is employed, the car having been designed for the hot climate of Spain.

The principal particulars of the engine with the larger bore, 102 B/2·8, are the same, except for the following details. A swept volume of 2,816 c.c. is obtained with a bore and stroke of 80 mm × 70 mm. Three compression ratios are available; they are 7·8 : 1, 8·2 : 1, or 8·8 : 1. Maximum power is developed at 6,300 r.p.m., and the maximum torque is 160 lb-ft at 3,600 r.p.m. A twin-choke Weber 40-mm carburettor is fitted or, as an alternative, the four carburettor arrangement may be employed.

Another variant was the 2·5 litre Pegaso Berlinette, which was among the several models shown. A Roots type blower is fitted to this model, which is designated the 102 BS/2·5. The choice of compression ratios is between 6·5 : 1, 7 : 1 and 7·5 : 1. Maximum power is developed at 6,800 r.p.m. and the maximum torque of 241 lb-ft is obtained at 4,000 r.p.m. Two horizontal 40 mm twin-choke carburettors are employed, and the ignition is effected by a magneto. No figures are available for the b.h.p. of this model.

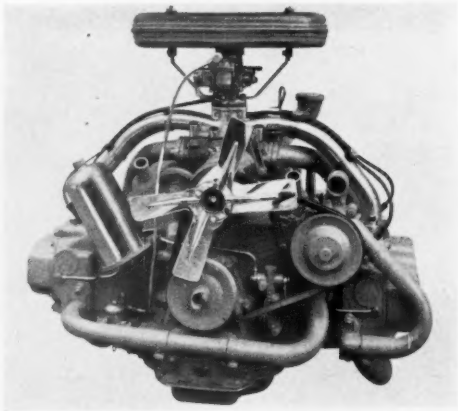
In all versions of the engine, a cast aluminium alloy crankcase is employed in conjunction with wet cylinder liners. Aluminium alloy is also used for the sump. Two connecting rods are carried on each crank pin. An unusual feature of the engine is that the big end bearing shells are of aluminium alloy. Bolted on the front of the crankcase is a remarkably complex cast-aluminium alloy cover, which houses most of the auxiliary components and their drives. In the base of this cover there are two gear type oil pumps, driven from a spur gear on the crankshaft, the larger one, which is on the right, is the scavenge pump. The pressure pump, on the left, feeds the oil through two filters in tandem.

The lubrication system for the many auxiliary drives is of necessity complex, since it is essential that oil shall always flow freely through the many drilled oilways. For this reason, three small inspection windows are provided, so that a visual check may be made to ensure that the whole system is functioning correctly. One window is on top of the front cover immediately behind the fan; the other two are at the rear end, one on top of each cylinder head. Two filters are fitted because of the necessity to keep all the oilways absolutely free from sludge. This arrangement is, as can be seen from the illustration, more compact than would have been possible with one large unit.

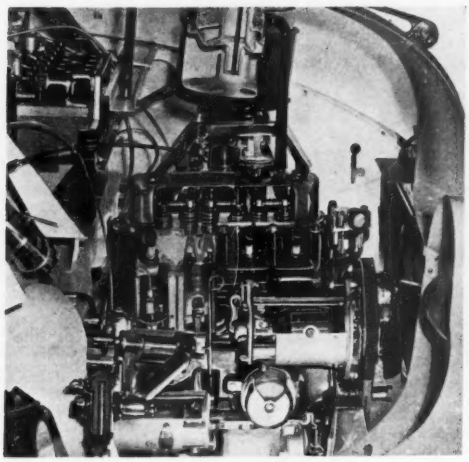
The centrifugal type water pump and the fan drive are housed in the front cover above the front end of the crankshaft. The water inlet is on the cover below the fan and slightly to the left of the pump. Two water outlets are provided, one at the front of each cylinder head. The magneto is bevel gear driven, and is bolted to the top face of the front cover in front of the left-hand cylinder head.

Spur gear trains, from the front of the crankshaft, drive the four overhead camshafts. The gears are enclosed mainly by two front covers, bolted to the front of each cylinder head and to the crankcase front cover, and the enclosure is completed by the camshaft covers. The cams bear on inverted thimbles which slide in guides cast integrally with the cast aluminium heads and partly enclosing the valve

On the Jowett Series III engine the filter is now installed between the fuel pump and the carburettor



An exhaust-heated hot-spot is incorporated on the Hotchkiss-Gregoire engine



The B.M.C. 803 cm³ engine installation in the Morris Minor

On the modified Riley 1½ and 2½-litre engines, an orthodox triangulated V-belt drive is employed

springs. This arrangement, of course, relieves the valve stems of side thrust. Two springs are employed with each valve.

Three drives are taken from the rear of the camshafts. On the extreme right is the engine speed indicator drive, and a gear type fuel pump is mounted at the rear of the other camshaft on the same cylinder head. The third drive is a pulley for the vee-belt of the dynamo which is bolted on top of the clutch bell housing. This pulley is carried on the rear of the inlet camshaft of the left-hand bank of cylinders.

Hemispherical combustion chambers are incorporated, and the valves are inclined in transverse planes above each cylinder. The inlet valves are on the inside, and the exhausts on the outside of the vee. Spark plugs, with 14 mm threads, are fitted between the valves in a very accessible position on top of the head.

The Triumph sports 2-seater has been designed specifically for dollar markets. Except for a few modifications, the engine is the same as that employed in the Standard Vanguard. For competition requirements different liners have been fitted to bring the swept volume down to 1,991 c.c. instead of 2,088 c.c. The bore and stroke are 83 mm × 92 mm instead of 85 mm × 99 mm, and the b.h.p. is 75 at 4,500 r.p.m., as compared with 68 at 4,200 r.p.m. Although the compression ratio is at present 7:1, it may shortly be further increased. On the model at the Show, twin S.U. carburettors, each fitted with an A.C. air cleaner, were employed.

To reduce the overall height of the radiator, and to allow it to be mounted lower so as to fit in with the front end styling, the A.C. pressure type filler cap is carried on the thermostat housing above the water pump. The cooling system is pressurized to 4 lb/in². It has been found necessary to mount the fan on the front end of the crankshaft instead of on the pump spindle. Provision has been made to drive an engine speed indicator through a bevel gear meshing with the gear on the distributor drive spindle.

A modified Regency engine is installed in the Daimler 3-litre convertible coupé. An aluminium cylinder head is fitted. It incorporates smaller combustion chambers which, in conjunction with high compression pistons give a compression ratio of 7·5:1 as compared with 6·7:1 in the Regency. The position of the valves has also been changed. They are now inclined at an angle of about 7 deg from the vertical, instead of 10 deg. This allows a straighter inlet port arrangement to be adopted. The valve lift has been increased, and the timing altered to suit the higher engine speeds. Maximum power is now developed at 4,400 r.p.m. instead of 4,100 r.p.m., and is 100 b.h.p. as compared with 90 b.h.p. in the Regency.

Among the other engines that have been modified is the Jowett flat-four unit. The crankshaft has been redesigned in detail to increase its fatigue resistance. Its crank pin and main bearing fillet radii have been increased from 0·05 in. to 0·10 in., and the hardening technique has been altered to ensure that the hardness does not extend to the crank webs, where it might introduce stress concentrations.

With the object of reducing the bending loads on the shaft, the weight of the crank pins has been reduced by drilling a ⅞ in diameter hole through them. The crankshaft oilways have been repositioned so that they meet the surface of the crank pins in an area of minimum load and there is less likelihood of a periodic interruption of the oil flow. All crankshaft bearings, with the exception of the rear journal, are now fitted with Vandervell trimetal shells. These are steel-backed copper-lead alloy, plated to a depth of approximately 0·003 in with lead-indium alloy.

In the crankcase, the oilways have been increased in diameter so that there is less likelihood of restriction due to the high viscosity of the oil when it is cold. To stiffen the structure and reduce noise, radial ribs have been incorporated on the front, centre and rear webs. The lower seal of the cylinder liners is now an oil- and heat-resistant rubber ring. This ring is positioned round the flange at the base. There is also a metal-to-metal joint between the bottom end and the crankcase, so that there can be no settling of the liner if the joint ring collapses. Thus, the initial pressure is maintained continuously between the top end and the cylinder head gasket. In the cylinder head, the combustion chambers are polished, and the ports are carefully aligned with the manifolds. These two measures are intended to reduce any tendency to run-on, and to improve the gas flow characteristics.

Several other modifications have been incorporated. One of these is an increase in the width of the piston ring lands to increase the fatigue resistance at this part of the piston. The oil pump capacity has been increased by approximately 25 per cent, and the unit is now submerged in the sump so that it is self-priming. This eliminates any difficulties that might be experienced under starting conditions. Previously a spring-loaded plunger in the front cover located the camshaft axially. This has been replaced by a positive screw adjustment stop that bears on the front end of the shaft and is secured by a locknut. The object of this alteration is to reduce noise arising from excessive

end float. A simple Lodge end fitting, made of rubber, is now employed to facilitate servicing.

Very few changes have been made to engines in the models produced by the Nuffield Organization which, with the Austin Motor Co., forms the British Motor Corporation. The Morris Minor Series III is powered by the B.M.C., 803 c.c., overhead valve engine. The only difference between this unit and the one installed in the Austin 7, described in the October issue of *Automobile Engineer*, is that an S.U., H1 carburettor with a 1⅛ in bore is employed. It is mounted at an angle of 30 deg from the horizontal.

The Wolseley Four-Fortyfour is powered by the M.G. engine bored out to 66·5 mm with a stroke of 90 mm, giving a swept volume of 1,250 c.c. The compression ratio is 7·3:1. To accommodate the single 1¾ in bore S.U. carburettor, which has an A.C., oilbath air cleaner, a modified induction manifold is fitted. All the M.G. range now have the oil filter bolted directly on to the pump. This eliminates the pipeline formerly used.

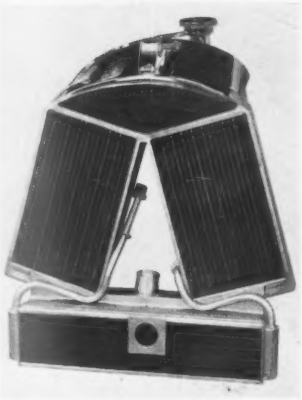
Both the Riley models have modified cams incorporating longer ramps among other features. A conventional triangulated vee-belt drive has been adopted as being simpler than the previous arrangement of a separate belt drive to the fan. Copper-lead bearing shells are fitted in the connecting rod portion of the big ends, and white metal lined shells in the caps.

On the 3 litre Alvis, the exhaust manifold is now made in two pieces to alleviate troubles due to expansion. Two S.U. H4 carburettors with a 1½ in bore are employed in conjunction with a thermo-electric choke control, for which the master switch is on the dash. The electric circuit is wired through the ignition switch, and a bi-metal strip, control unit is bolted on the rear of the cylinder block.

Other manufacturers have made minor alterations to their power units. Frazer Nash have increased their crankshaft journal bearing diameters by 0·2 in, thus increasing both the bearing area and the crankshaft stiffness. The breather is now mounted on the tappet cover, instead of two being fitted, one on each rocker box. A Marsden film-type oil cooler replaces the finned tube unit. It is served by larger diameter flexible pipes.

The Sunbeam Talbot 90 now has a larger water pump outlet and distributor tube in the head to obviate any tendency towards running-on. With the same object in view, the temperature at which the thermostat valve lifts has been reduced from 167 deg F to 160 deg F, and deflector plate which partly screens the exhaust-heated hot-spot has been fitted.

There were many interesting exhibits on the accessory stands. Delaney-Gallay Ltd. showed the radiator for the Cooper-Bristol. The radiator is supported on three Silentbloc rubber bushed tubular mountings,



The Delaney-Gallay radiator and oil cooler for the Cooper-Bristol racing car

two at the base and one at the top. Space available at the top was limited but, lower down, there was practically no restriction. This led to the development of the inverted vee-shaped radiator block form shown in the illustration. The two arms of the vee are separate strip-tube blocks joined together by the header and base tanks. A similar type of block is mounted on an angle bracket welded to the front of the base tank. This is the oil cooler and, unlike the two radiator blocks, it is dipped in solder to give it adequate strength to withstand pressure.

The ingenious feature of this radiator unit is the installation in the car. On each side, the bonnet as it is brought forward is swept in to form a baffle to deflect outwards the heated air from the radiator. Cold air, entering through the triangular space between the arms of the vee, passes over the engine and out through louvres in the scuttle.

Serck Radiators Ltd. are producing a radiator with a block of somewhat unusual design. It has been designed for the American Caterpillar tractor now being produced at Coleville. This type of vehicle is required to operate under exceptionally dusty and muddy conditions on open-cast mining, and other sites. Accordingly, one of the chief problems is to make a block that will not easily foul. If it does so, it must be easy to clean with a hose, for example.

The problem has been solved in the following way. Three rows of strip tubes of large cross-section are employed. They are arranged so that the tubes, instead of being staggered in the usual manner, are positioned one behind the other in threes. Moreover, only five fins are fitted per inch. Thus not only is there a straight through flow for both cooling air and for water from a hose used when cleaning the unit, but the wide spacing of the components tends to prevent fouling.

Laystall Engineering Co. Ltd. have recently developed an aluminium cylinder head for the T.D. M.G. It incorporates the larger inlet valve which for some time past has been available as an alternative to give improved performance. In addition, the inlet ports are longer as well as straighter. The manufacturers claim that an engine, fitted with this head and having a compression ratio of 9:1, has been tested and found to run satisfactorily on pool petrol. It is said to have developed approximately 25 per cent more power than the standard engine. The new head is readily interchangeable with the normal cast iron head, since standard connections and manifolds are used.

W. G. James Ltd. now deposit a hard chrome finish, about 0·0005 in thick, on some of their valve stems to improve their wear resistance, and the stem ends are induction hardened instead of flame hardened. With new plant now being installed, they hope to be able to forge to a tolerance of 0·005 in. This will be particularly important in connection with the manufacture of valves for diesel engines, in which the valve head tolerance is critical, because of the small clearance between the heads and pistons. By thus accurately forging the valves, an operation to grind the heads to size will be eliminated.

The British Piston Ring Co. Ltd. are now producing chrome plated piston rings with square cornered working faces. Hitherto it has only been possible to chamfer or radius the corners, and this, they state, has not been completely satisfactory from the point of view of oil consumption. The cornering is effected by removing a rectangular section portion from the two corners of the ring face.

A new feature on the stand of Hepworth and Grandage Ltd. was the Oilmaster Ring Sets for engines in which the oil consumption is high, but in which the wear is not enough to justify a rebore. For a three-ring piston, a taper-faced top ring is supplied, together with a spring-backed second compression ring, and the Hepoflex, spring-backed oil-control ring. Where two oil-control rings are required, the lower one is the Super Drainoil Scraper Ring. For a five-ring piston, the first two compression rings are the same as for the three-ring piston, except that the top taper-faced ring is chromium-plated. The third compression ring is a plain taper-faced component, and the first and second oil-control rings are respectively the Hepoflex and Super Drainoil Scraper Rings.

Sterling Metals Ltd. were displaying some Elektron magnesium castings. This material is stated to be about 40 per cent lighter than aluminium. It is used more extensively on motor vehicles manufactured in the U.S.A. than in this country. Although Elektron magnesium is more expensive than aluminium, the extra cost may, in many applications, be offset in a great degree by reduced machining costs.

CARBURATION AND INDUCTION SYSTEMS

Developments to give a Lower Bonnet Line

APART from the introduction of the four-barrel carburettor on some American V-eight engines and the trend towards making downdraught carburettors shorter, no radical changes were evident in the carburation systems exhibited. So far as the carburettor itself is concerned, the open-choke type remains a great deal more popular than its constant-vacuum rival. None of the American and Continental exhibits had a constant-vacuum type of instrument. Among the open-choke variety of carburettor were the Zenith, Zenith-Stromberg, Solex, Carter, Bendix-Stromberg, Holley and Weber. The Zenith-Stromberg is, of course, a Zenith product, as distinct from the Bendix-Stromberg, which is produced by the Bendix concern at Elmira, U.S.A. The only constant-vacuum carburettor exhibited was the S.U. This is a standard fitting on cars of the Nuffield Group and on a number of other British makes. The downdraught type of carburettor continues to hold the field where the open choke instruments are concerned, but all the S.U. constant vacuum carburettors were of the horizontal or "side-draught" pattern. On some sports or semi-sports cars the horizontal S.U. carburettor is tilted up so that it becomes in effect a semi-downdraught. The downdraught carburettor was introduced over twenty years ago, and has held almost undisputed sway ever since. However, the present trend towards lower bonnet lines is beginning to render the downdraught carburettor rather inconvenient, and there are indications that the horizontal instrument may return to favour. One such example of this trend is the new Nash power unit fitted in the Nash-Healey, where the carburation equipment is provided by a pair of Carter horizontal carburettors of new design.

Although only twenty years ago the carburettor with an economiser and accelerating pump was regarded as a complicated horror, virtually every open choke instrument of 30 mm throttle bore and over now incorporates these items as a matter of course. Cold starting systems are receiving more attention, and this is as it should be. As we must export to live, many vehicles must go to the western areas where really cold winters are experienced. American motorcar manufacturers have this problem on their doorstep and their cars have to be really good cold starters. British cars have not always been so successful in this respect, and it is doubtful even now whether sufficient attention is focused upon this most important detail. With the American contingent of exhibits, the use of the thermostatically controlled automatic choke starting system is almost one hundred per cent. While some British manufacturers, of the more expensive products, including Rolls-Royce, continue to fit this system, there are indications that it is not popular with makers of the cheaper cars, doubtless on account of its effect upon short-journey petrol consumption. For example, this starting system has been fitted to the Humber Hawk for a number of years, but the Hawk Mk-5 exhibited had a hand controller with a semi-automatic strangler valve and interconnected fast idle.

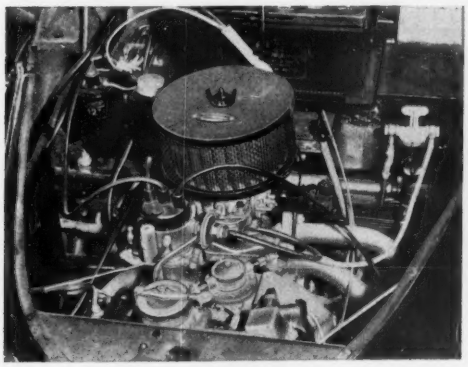
During the last year or so a good deal of development has taken place in American carburettors. Chief among these is the attempt to lower the downdraught carburettor and so provide more under-bonnet space to produce a lower bonnet-line. This is more marked in the case of the V-eight engine, where the downdraught carburettor furnishes the most practical carburation system. Another innovation is the production of the four-barrel carburettor, one version of which is the Bendix-Stromberg "Aeroquad" A very similar carburettor is produced by the Carter concern. In fact, the two are so alike that they might be manufactured to a common design. Intended for use on eight-cylinder engines, the system is so arranged that two barrels are in use for normal cruising, the other two barrels being brought into action for high power. Both the Bendix-Stromberg and the Carter versions are equipped with automatic chokes of the hot air pattern.

Another noticeable feature of the Show was the increasing use of the oil-bath air cleaner, sometimes separated from, and sometimes incorporated with the air silencer. Most of the American contingent had the single combined unit. In some applications they were of proportions that almost dwarfed the engine.

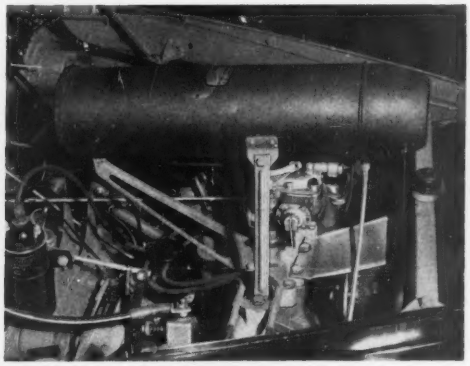
Mechanical fuel pumps, generally of A.C. manufacture and fitted to the side of the engine crankcase continue to hold preponderance over other kinds, despite the disadvantages of heat transfer to the fuel with resulting vapour formation. The S.U. electric fuel pump, also of the diaphragm pattern, was employed on some exhibits, and is standard equipment on the Nuffield Group of vehicles. New to this country, although widely used in the States for some years, is the new A.C. combined mechanical fuel pump and windscreen wiper booster. This unit was exhibited on the Ford Consul and Zephyr engines.

Induction systems again provide the usual wide variety of design, so much so that the student must inevitably pause to wonder which can be the best, and why.

Four-cylinder engines followed much of a pattern and were usually of the two-or four-port branch designs. A great deal more variation was to be observed on the six-cylinder engines,



New dual downdraught carburettor scheme on the Panhard Junior



Single Solex downdraught carburettor on Hotchkiss-Gregoire flat-four

for they lend themselves to so many arrangements. Almost every possible variation was on view. Again, in the matter of hot-spots there was a very wide range of different applications. Exhaust heated hot-spots were the most popular, and there were a number of varying schemes from the plain contact type to the elaborate thermostatically controlled heat valve. Some manufacturers exhibited coolant heated hot-spots, but these were in the minority. Rolls-Royce and Bentley still prefer this design, but here again it may be a matter of expediency, as the exhaust manifolds are on the opposite side of the engine.

Although the new Vauxhall Wyvern engine is a complete re-design to the fashionable "square" specification, the main features of the carburation system are much the same as those employed by the Vauxhall concern for some years. They include the usual induction manifold over the exhaust, arranged on the left-hand side of the engine. The thermostatically controlled hot-spot valve, pioneered by Vauxhall in this country, is retained, together with a ⌂ section manifold tract. A Zenith downdraught carburettor with part throttle economizer and accelerating pump supplies the two-port induction tract.

From the hot-spot jacket the two galleries bend inwards towards the cylinder head and fall somewhat sharply to the cylinder head ports. As in the case of the new Velox engine, the induction tract is kept parallel with the ground, although the engine is mounted in the chassis with a transmission angle. This means that the rear port branch drops more to meet the cylinder head port than does the front one. Previous Vauxhall practice is retained, where the hot-spot valve plate spindle is arranged parallel with the crankshaft, with the bi-metal thermostat spring located at the rear, away from the draught of the fan, and the counter-weight bob in the front. When in the cold position, the counter-weight rests against a pad held by a small bracket, attached to one of the manifold bolts.

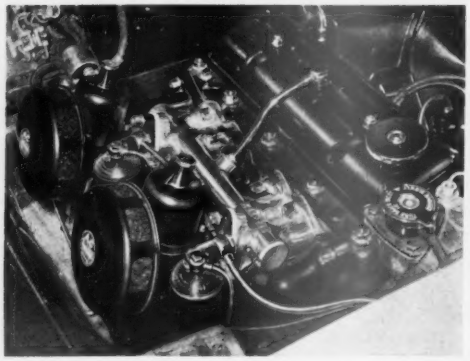
Exhibited for the first time in this country, the Kaiser Henry J. Corsair power unit is the Willys 2·2 litre four-cylinder side valve engine. On this the carburation system follows the conventional lines employed on American six- and eight-cylinder engines, with both induction and exhaust manifolds on the same side, together with a thermostatically controlled hot-spot. An ordinary flat two-port induction manifold of round section arranged on the left-hand side supplies the two siamesed inlet ports in the cylinder block. The two exhaust manifold branches from the outer exhaust ports curve up and over the induction manifold, and down to meet the centre exhaust ports, where they join the box casting containing the hot-spot heat valve. It is surprising to see the bi-metal thermostat spring placed on the front end of the heat valve spindle, where it is subject to the draught from the fan. This may be a matter of production costs, since the bob-weight is located on the front of the spindle also and there is no protruding end of the spindle at the rear. The air silencer is of unusual shape, being about a foot in diameter and some four inches deep. It is joined to the downdraught Carter carburettor by an extension and right-angle elbow piece. A combined mechanical fuel pump and windscreen wiper booster is mounted low down on the left-hand front of the engine, and a reinforced asbestos heat shield is provided to protect the pump from exhaust heat.

For sports cars twin carburettors are commonly employed. The new Triumph is no exception. It has a Triumph Renown engine, but a different carburation system. In place of the usual four-port branch induction tract and single downdraught carburettor, the Sports version is fitted with a straight-rake manifold of round section, with two horizontal S.U. carburettors tilted up at a slight angle, so that they become semi-downdraught. The inlet ports on the cylinder head are spaced in pairs very close to one another at each end of the head. This therefore also brings the two port branches of the induction manifold very close together, and there is very little room for the carburettors to be spaced between them. Disc type air silencers of A.C. manufacture are attached to the air intakes of the carburettors.

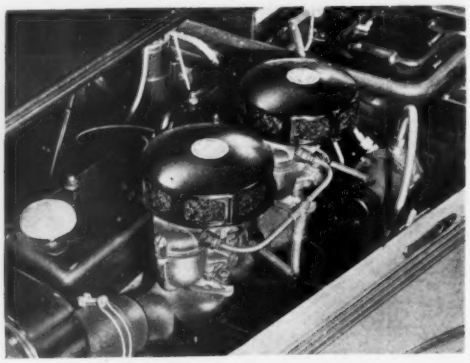
Singer on the other hand employ two downdraught Solex carburettors on the SM Roadmaster. As on the SM-1500, there is an internal induction gallery running the length of the cylinder head, and from which the four individual inlet ports lead down to the inlet valves. Two risers and inlet bends are cast integral with the exhaust manifold. They feed the mixture into the internal gallery through two ports cast in the cylinder head. The right-angle bends below each carburettor are thus exhaust heated, and doubtless provide excellent drive-away from cold. From a well in the bottom of each inlet bend, a drain pipe is led away down in line with the exhaust pipe. Here again small disc type air silencers are mounted direct on the carburettor intakes.

Conventional Wolseley design is retained in the carburation system of the new Four-Fortyfour model. The two-port round section induction manifold is cast integral with the four-port exhaust, the induction being placed above so that the junction of the two manifolds form a hot-spot. Mixture is supplied by a horizontal S.U. carburettor mounted in the tilted position now popular. An end-feed air silencer is connected to the intake of the carburettor by a curved intake tube.

Carburation on flat-four engines is always something of a problem. On the new Gregoire-designed engine Hotchkiss have chosen the simplest method by employing a single downdraught carburettor, feeding into the middle of a long induction pipe leading down to the siamesed inlet ports of each bank of two cylinders. The induction pipe is fabricated of steel tubing and in the centre of the pipe, underneath the riser, is a flange to which is bolted the hot-spot casting. Exhaust gases are passed through the casting by means of large bore tubes, one of which is taken from the exhaust ports located on the underside of the



The Triumph sports car has twin semi-downdraught S.U. carburation and a new induction system



Twin Solex downdraught carburettors with exhaust-heated riser elbow tracts on Singer SM Roadster

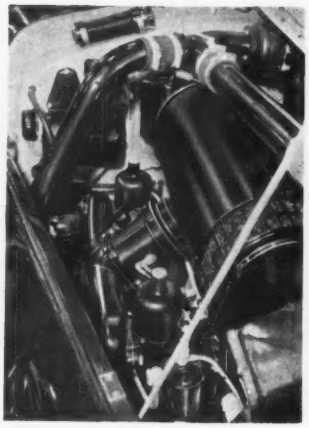
left-hand bank. The other pipe leads from the hot spot casting down to meet the exhaust pipe from the right-hand bank. A glass-bowl petrol filter is interposed between the carburettor and the petrol pipe, the filter being screwed directly into the carburettor petrol inlet of the downdraught Solex carburettor. Mounted in a forward facing position on the carburettor is a long cylindrical License Vokes air silencer.

A somewhat unorthodox induction system is employed on the new Sapphire 3·4-litre Armstrong Siddeley engine. This power unit, of wholly new design throughout, breaks fresh ground as far as Armstrong Siddeley is concerned, at any rate during recent years. Hemispherical combustion chambers, inclined valves and a valve gear of the cross-push rod variety from a single camshaft on the right-hand side of the engine, form a combination quite different from the conventional lozenge type o.h.v. engine produced by this concern since the war.

Armstrong Siddeley engines have long used the six-port internal induction gallery cast in the cylinder head. But to employ this arrangement in conjunction with a hemispherical head is something quite different, and the designer deserves great credit for attempting to combine the known advantages of this layout with a high performance design in other respects. The internal gallery runs the length of the cylinder head casting and is of circular cross section. From each inlet valve the six inlet ports run into the gallery at an angle, sloping backwards from the valve port into the gallery. Following the usual Armstrong Siddeley practice, a balance orifice is located in a small separate casting detachable from the head, and secured in place by an outside flange and two small bolts.

It will be recalled that with the existing Eighteen engine the internal gallery is fed by a two-port external manifold. In the Sapphire however, a four-port external manifold is used in conjunction with a single downdraught Zenith-Stromberg carburettor of the part-throttle economizer type. This unusual manifold arrangement thus has two induction branches feeding into each half of the internal gallery, the design being such that each of the four branch port outlets into the main gallery faces a blank wall between the inlet valve ports of Nos. 2 and 3, and 4 and 5. The external induction manifold is of aluminium and of circular cross section.

As the exhaust manifold is on the opposite side of the engine, a coolant heated hot-spot is employed. This consists of a water jacket surrounding the junction of the riser "T" with the manifold tract. Hot coolant is fed direct from the cylinder head into the jacket through a short tube connecting the head with the manifold hot-spot casting. From this point the coolant is returned to circulation through a large bore copper pipe to the water pump. From the riser the two manifold branches rise sharply and then straighten



New automatic choke system on the Bentley, showing strangler lever and thermostat rod. Standard S.U. carburettors are used

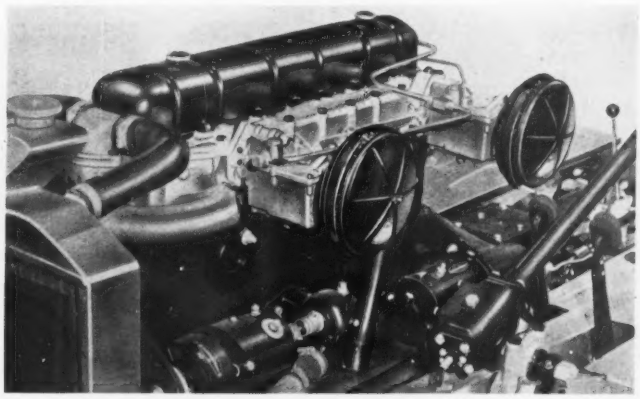
out, so that essentially the galleries are flat. The outer ends of the manifold turn inwards in a gentle curve to form the outer port branches, while the two inner port branches lead straight inwards from the manifold to the cylinder head ports. Beneath the riser and gallery junction there is a deep sump, from which the manifold drain tube is taken.

To retain a stable idle, a ball valve is fitted to the bottom on the drain tube. Accelerator to throttle control is by a pull rod system and a large "L" type A.C. air silencer is mounted across the engine, above the valve tappet cover. The fuel supply to the carburettor is by an A.C. mechanical fuel pump complete with glass-bowl petrol filter, mounted on the off-side of the engine. As on the Eighteen, the exhaust silencing system comprises a primary expansion box followed by an exhaust silencer proper. With the new engine however, the exhaust manifold is formed of two separate castings, each having three ports, so that the front manifold exhausts cylinders 1, 2 and 3, and so on. Two separate down pipes are employed. They run directly into the expansion box located to the lower rear of the engine. From the expansion box the single exhaust pipe leads down to the silencer, placed a little more than half way down the length of the chassis.

Another newcomer to the British field, the power unit of the new Humber Super Snipe presents something quite different from previous Humber practice. This o.h.v. engine with lozenge-shaped combustion chambers has vertical side-by-side valves, and both inlet and exhaust valves have separate ports. The three-port branch induction system so long favoured by Humber is now replaced by a straight-rake six-port branch design. Arranged on the left-hand side of the engine, the aluminium induction manifold casting is placed above the six-port branch exhaust. It is evident that cold weather starting has been much in the designer's mind in scheming this system, the design showing the result of much careful thought, and doubtless much development work also.

As usual with this arrangement, the two manifolds are bolted together in the middle, and between the two mating flanges there is a stainless steel thin-plate hot-spot of large area. Welded to the underside of the plate is a collector piece for directing the exhaust gases on to the plate. The idea is similar to that used on the Austin Sheerline induction system, but on that engine the deflector is a casting attached to the plate hot-spot. On the Humber engine the main induction gallery is of the rake type when viewed in plan.

From the extreme ends of the gallery, the two tracts fall towards the hot-spot, where a manifold drain is placed. The engine has a transmission angle of some 5 deg when in the chassis, and to ensure effective cold operation drainage, the rear end of the gallery rises more than the front one. As a result the port branches are not symmetrical with the



New horizontal Carter carburettors on the Nash-Healey

gallery throughout, the front three branches rising from the top of the gallery tract, while the three rear ones lead inwards towards the cylinder head in line with the gallery. In cross section the gallery tract is ∩ shaped. This is also in keeping with cold operation. The spacing of the six-port branches is somewhat unusual. Nos. 1 and 2, and 5 and 6 are close together at each end. There is then a large gap between Nos. 2 and 3, and Nos. 4 and 5. As usual, the exhaust branches of Nos. 1 and 6 are at the extreme ends. The downdraught Zenith-Stromberg carburettor is mounted on a rather short riser of a length that is doubtless dictated by the bonnet space available. An automatic choke of the usual Zenith-Stromberg type is incorporated, the thermostat unit being located in a small well cast on the side of the exhaust manifold. A mechanically operated accelerating pump with vacuum operated economizer for part throttle economy is contained within the carburettor.

Previously Humber models have had throttle controls of the cable type. This is now superseded by a rod system throughout from the accelerator pedal to the carburettor, the last portion of the control being of the torsion rod pattern, that twists the throttle valve lever instead of pulling it. Possible vapour troubles have evidently not been overlooked, for not only is there a reinforced asbestos heat shield under the carburettor between the throttle body and the induction riser, but there are similar heat shields over the A.C. mechanical fuel pump and the separate petrol filter. The fuel pump, which has its own glass-bowl filter, is located on the right-hand front of the crankcase, while the independent petrol filter is placed on the same side but above the pump. Although the position of the petrol filter may be criticized, it is obviously most difficult to suggest a different position under the bonnet where it would be in a cooler spot.

A large combined oil bath air cleaner and silencer is mounted on the right-hand side of the chassis towards the front of the engine. From the top of the cleaner a long length of corrugated hose leads over the top of the rocker cover to a wide and flat intake elbow, which fits over the top of the carburettor. From the underside of this fabricated metal elbow a fume extractor pipe is taken down into the top of the rocker cover. In common with other Rootes products, the induction manifold drain pipe has a non-return ball valve at its lower end.

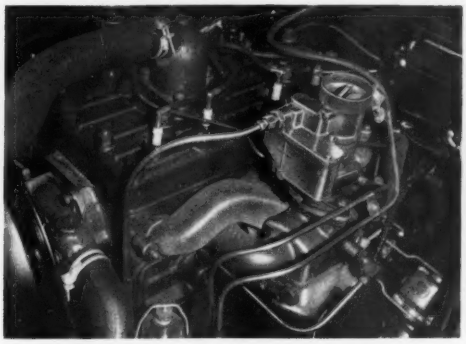
Also prominent among the newcomers was the new Vauxhall Velox with the "square" engine. For this the carburation system follows closely on the well known Vauxhall designs, including the retention of the thermostatically controlled hot-spot. Mounted on the left side of the engine, the three-port induction manifold is of cast iron and is arranged above the six-port exhaust. Junction between the two is, as usual, in the centre, where the two are bolted together. A hot-spot jacket of generous dimensions surrounds the junction of the riser "T" with the gallery. Hot exhaust gases are fed into the jacket from the exhaust manifold below, where the heat control valve is situated. In general design, the induction system is similar to previous designs, the tract being ∩ shaped in cross section. The engine is inclined in the chassis to provide a transmission angle, but the induction gallery is so arranged as to be parallel with the ground. Thus the rear port branch has a greater fall to the cylinder head ports than does the front port branch. While the gallery is horizontal, the front port branch falls some 2 in to the cylinder head port, the bend downward being rather sharp. As on the Wyvern the thermostatically controlled hot-spot is of the type which has been used on Vauxhall engines for many years. Attached directly to the top of the Zenith downdraught carburettor is an air silencer of astonishingly small dimensions for the size of the engine. Instead of the torsion rod throttle control previously employed, the accelerator control is now of the pull-push type, with a large pull-off spring anchored to the lever on the front of the bulkhead. This is to be commended, since the main effort to bring the throttle and accelerator pedal mechanism to the closed position is remote from the throttle spindle. Far too often the only return spring on the whole system is attached to the throttle lever, a method which usually promotes undue wear on the throttle spindle and often produces a sticky and jerky feel to the accelerator pedal. This is particularly true of some cable accelerator controls.

The only American engine exhibited designed on the F-head principle, with o.h.v. inlet and side exhaust valves, the Willys Overland, has the induction tract cast within the cylinder head. This is seldom encountered in American design although the Nash have long favoured this scheme. On the Willys Overland engine the tract is contained in a protruding portion on the right-hand side of the cylinder head casting. A downdraught Carter carburettor is bolted to the top centre of the casting and separate inlet ports lead from the internal tract to each individual inlet valve. The tract is thus water heated over its entire length, another departure from orthodox American practice. Located on the left side of the engine is the six-port exhaust manifold, an arrangement which renders water heating of the mixture a virtual necessity.

An internal gallery induction tract is also incorporated in the power unit of the Nash-Healey. This is the new o.h.v. Nash six-cylinder engine, which was not exhibited in the range of Nash cars at the Motor Show. Cast in one-piece with the aluminium cylinder head, the induction tract is of rectangular cross section, the top of which is open. A cast aluminium cover plate forms the top wall of the tract, and is secured by a number of studs and nuts along the top. Two horizontal Carter carburettors of new design are employed. They are bolted to the side of the induction casting. Underneath the induction tract is the exhaust manifold, which is in fact formed of steel tubing. Holes in the tubing match with the

Four-barrel carburettor and enormous air cleaner on the Oldsmobile Rocket

Induction arrangement on the De Soto Firedome V-eight. Note lagging on thermostat hot-air pipe



Carter carburettor and induction system on Kaiser Henry J. Corsair

Alfa-Romeo carburettor, air silencer and exhaust manifold arrangement

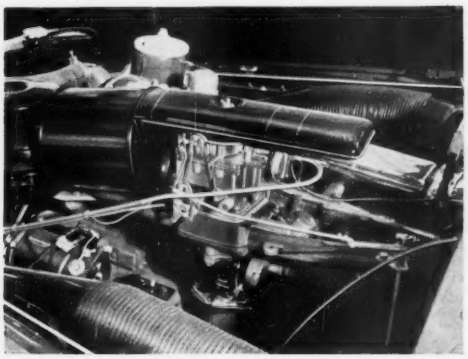
exhaust ports in the cylinder head, the tubing being clamped into a reamed groove in the head by steel clamping pieces. This scheme was first employed by the Nash concern a few years ago, and it is now used by Ford on the Consul and Zephyr models. Both carburettors are equipped with the Carter automatic chokes of the hot air pattern. Of particular interest is the pressed steel assembly forming the connection between the two throttle spindles, which should be both cheap to produce and effective.

About this time last year Rolls-Royce introduced a change of carburation system on the Silver Wraith model. This was the employment of a single downdraught Zenith-Stromberg downdraught instrument in place of the dual model previously fitted. The standard Zenith-Stromberg form of automatic choke was retained, where the usual combination of off-centre mounted strangler valve with vacuum "kick-open" stepped fast idle cam and bi-metal thermostat unit provides an automatic control of the mixture strength during cold starting and the warm-up period. As before, the thermostat unit is housed in a recess cast in the water heated hot-spot, so the thermostat is subject to coolant heat instead of the exhaust, which is the more common practice. This system has been retained and the Rolls-Royce cars exhibited were so equipped.

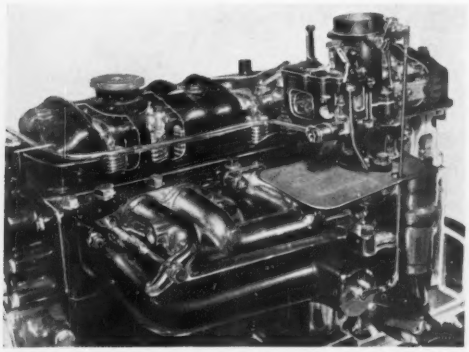
On the Bentley however, a radical alteration has been made by the incorporation of a similar version of the automatic choke to the existing twin S.U. carburettor scheme. It will be recalled that with the Bentley arrangement the air silencer lies along the top of the rocker cover, and the air intakes of the two S.U. carburettors are connected to the centre of the air silencer by a T-shaped casting. With the new automatic choke the large off-centre mounted strangler valve is placed in the leg of the "T", which is joined to the centre of the air silencer. From a lever on the outside of the strangler spindle a rod is linked to the lever of the thermostat unit, which is placed as before in a recess cast in the coolant heated manifold.

The thermostat unit is basically the Zenith-Stromberg, but with a longer spindle to accommodate two of these bi-metal springs instead of the usual single one. Twin springs are necessary owing to the larger size and consequently greater weight of the strangler valve. Another rod is linked from the strangler lever to a stepped fast idle cam, so situated that a fast idle stop screw on the front carburettor engages with the cam when the strangler is in the closed or cold position. Instead of the vacuum piston generally employed to open the strangler valve when the engine fires from cold, a vacuum operated diaphragm is used. As in the case of the vacuum piston, the amount of strangler opening at the initial fire is governed by a stop screw. Owing to the greater size of the strangler valve a solenoid is incorporated in the system to hold the strangler fully closed when the starter button is pressed.

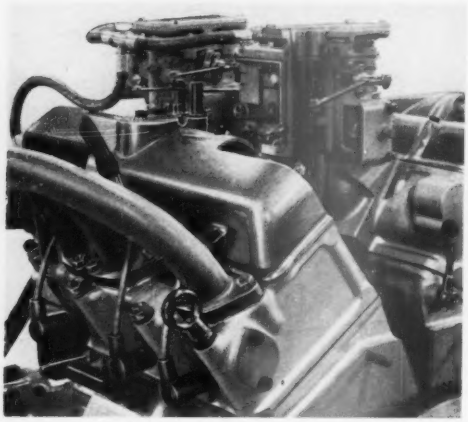
It will be remembered that the American Sisson automatic choke possesses this feature of the solenoid for fully closing the strangler valve. Also different from previous Bentley models is the arrangement of the float chambers of the two carburettors. Whereas formerly both float chambers were placed to the front of the carburettors, in the present scheme the float chamber of the front carburettor is in front of the carburettor, but that of the rear carburettor is behind. The position of the dual S.U. fuel pump assembly is unchanged, being located about midway



On the Buick a four-barrel Stromberg replaces the dual carburettors previously employed



Six-port induction, downdraught Zenith-Stromberg economiser carburettor and automatic choke on the new Humber Super Snipe



New Fiat V8 twin dual downdraught Weber carburation system showing sectioned carburettor

Thermostat-controlled hot-spot system on the Vauxhall Wyvern Zenith downdraught carburettor

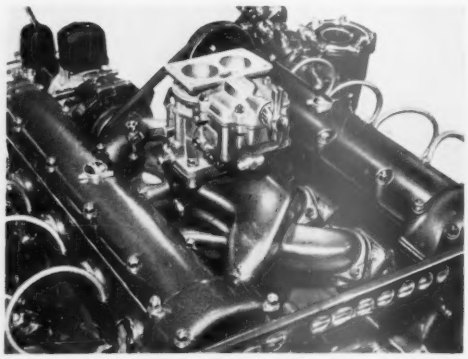
along the chassis frame and bolted thereto. This is an excellent position, as the pump is remote from the heated area under the bonnet and should thus be fairly free from vapour troubles. On the standard model, twin exhaust systems are employed, each set of three cylinders exhausting into separate tracts leading to separate exhaust silencers and tail pipes. Like the Zenith-Stromberg system, the throttles must be opened once before a cold start is attempted, in order to lift the fast idle stop screw clear of the fast idle cam.

Producing excellent power for its capacity, the new Fiat V-8 is carburetted in a somewhat unusual manner. Instead of the individual inlet valves and cross-over induction tract which have become general on V-8 engines, the Fiat employs two dual downdraught Weber carburettors, each barrel of which feeds two siamesed inlet valve ports, one in either bank. The risers form part of the cylinder head castings, so that there are two risers on the inside of each head, and opposite to the risers on the other head. A balance tube about one inch in diameter joins the two risers on each side. Fitted direct to the machined tops of these risers are the two dual downdraught carburettors, one barrel feeding the port of one head and the other barrel the port on the other. It must be difficult to maintain these two induction flanges at equal height in production, because the carburettor must seal down across both. When several such angles are involved, this could become quite a problem.

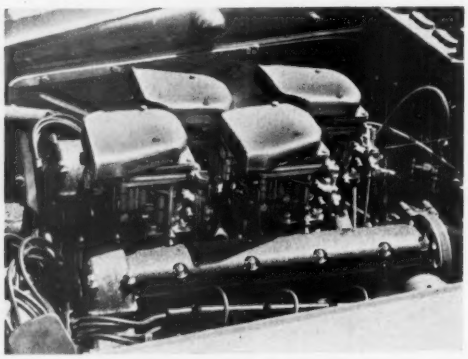
In order that the carburettor throttle valves should each open in the opposite directions, the throttle spindles are parallel with the crankshaft, and geared together, in a similar fashion to the American Bendix-Stromberg aircraft carburettors. To employ such a system on a motor car carburettor would render it very expensive to produce. The sectioned carburettor exhibited reveals the discharge system to be of the double venturi type, very similar to the existing Zenith-Stromberg. A fabricated four-branch exhaust manifold is bolted to the top of each cylinder head, with the off-take flange arranged in the middle, where the four branches meet.

Surprisingly enough, nothing could be more conventional than the induction arrangement on the Pegaso V-8 engine. While it was difficult to obtain technical information, it is clear that the carburation system on the polished chassis exhibited closely follows the orthodox inter-leaved tract arrangement initiated by Ford some years ago. In common with current American designs of this system, four separate inlet ports per bank are fed from the dual downdraught carburettor, and an extra port branch on each side of the manifold casting leads exhaust gas to the underside of the riser and gallery junctions. Weber carburettors are fitted to all three versions of the Pegaso.

With the four-carburettor model, four downdraught Weber carburettors are used. They are so arranged that one barrel of each carburettor feeds an inlet port on one side and the corresponding port on the opposite bank.



Pegaso V-eight dual Weber carburettor version with conventional induction system



Four carburettor version on the Pegaso V-eight

In the case of the supercharged version, the large Weber supercharger lies along the vee, parallel with the crankshaft, and takes its mixture supply from a large dual carburettor at the rear of the engine.

Although the general design of the induction systems on the American V-8 engines has altered little in recent years, there has been a good deal of development in American carburettors. These developments have been directed chiefly for the attainment of greater power from the engines and the reduction of height. Both the Lincoln and the Mercury were equipped with the Holley Centriflo dual downdraught carburettor. This extremely ingenious design reduces the combined height of the carburettor and air silencer by almost half. The construction is such that the large air silencer fits round the outside of the carburettor, in such a manner that the outer wall of the carburettor is formed, as it were, by the inside of the air silencer casing.

The new De Soto Firedome V-8 engine contains the orthodox cross-over interleaving induction system common to most American engines of this type, together with a hot-spot heated by passing exhaust gas through the manifold casting. An interesting feature however, was the extreme shortness of the new dual downdraught Stromberg carburettor. Also of this conventional design is the induction system of the new Dodge V-8 power unit, similar in essentials but smaller than the Chrysler V-8 engine. Induction systems of the same type are used on the Cadillac, Oldsmobile and Chrysler V-8 engines, but these models incorporate versions of the new four-barrel carburettor. These may be either the Stromberg "Aeroquad", or the four-barrel Carter which resembles it very closely. With this type of carburettor two barrels are in use for normal cruising speeds, the other two barrels being brought into action for high power.

CLUTCHES

Single-disc is Standard but More Interest Shown in Centrifugal Operation

As far as the great majority of vehicles was concerned there was little of interest respecting clutches, since the dry disc is almost universal and is nearly always of Borg and Beck manufacture. In some 1953 British models larger clutches than those formerly in use are now fitted; a change from an 8 in to a 9 in disc was a case in point. Some sporting drivers may not be so grateful for this as might be expected, since with the average synchromesh mechanism there is difficulty in accelerating the mass of a larger disc in making a rapid upward change. One or two of the Continental cars are remarkable for the small size of their clutches, notably the Lancia Aurelia, described in connection with last year's Show, in which ground clearance sets a limit to the diameter of the assembly which comes on the lower shaft of the combined rear axle drive and gearbox.

The new Fiat 1900 also has a fairly small clutch, but to this no objection can fairly be raised since it is in series with a fluid flywheel which takes care of nearly all the slipping. This car happens to be one of the several Continental makes using a five-speed gearbox, the top gear being a rather high overall ratio. While this gives smooth and silent travel at high speeds it is clear that the characteristics of the fluid flywheel will require careful consideration if the expected fuel economy is to be realized. In the hands of many drivers the car may do a lot of running at modest speeds in overdrive ratio. In a moderately hilly district the engine may, therefore, be called on to pull hard at speeds at which fluid flywheel slip would normally be considerable.

A centrifugally operated, dry-disc clutch is again a feature of those of the new Armstrong Siddeley Sapphire cars to which a Wilson gearbox is fitted. This clutch is of highly refined design, and every effort has been taken to secure progressive engagement. The clutch disc, for example, has its front and rear facings attached to two separate discs, with interposed cushioning springs. The presser plate is operated by bell-crank, bob-weight levers bearing on a thrust plate. This transmits the load to the pressure plate by a number of pre-loaded compression springs. Graduation of engagement is thus assured and, since the travel of the thrust plate is limited, the maximum pressure on the pressure plate is determined not by the centrifugal force, which is unnecessarily large at high engine speeds, but by the preloaded springs.

The centrifugal clutch is therefore always available as a "safety valve" to cushion any shocks that might otherwise be felt as a result of too rapid engagement of a gear band in the Wilson box. In this respect the centrifugal clutch, as developed by Armstrong Siddeley, is superior to the fluid flywheel which, at high speeds, gives an almost solid drive capable of transmitting many times the engine torque.

A special centrifugal dry-disc clutch may be said to form the "heart" of the new Manumatic gear-change introduced by Automotive Products Ltd. In this the bob-weights come between the presser plate and the thrust plate. Though they act directly on it, engagement is cushioned as the thrust plate is backed up by the usual clutch springs. The normal withdrawal levers and thrust bearing act on the thrust plate. Since the travel of the bob-weights is strictly limited by stops, the normal withdrawal mechanism can at all times disengage or engage the clutch irrespective of the action of the centrifugal weights.

Centrifugal clutch of Borg and Beck Manumatic transmission

In normal running the thrust plate is held, by the withdrawal mechanism and against the pressure of the clutch springs, in such a position that at quite low speeds the bob-weights, under the pressure of retraction springs, allow the presser plate to disengage. The clutch is therefore free on the tick-over and a start from rest can be made without using the clutch pedal.

Provision is made whereby, if required, the withdrawal gear can be released slightly, allowing the thrust plate to move further forward until the presser plate is engaged again, in spite of the fact that the engine speed is low and the bob-weight pressure withdrawn. By this means the car can drive the engine from a position of rest, making a tow-start possible in spite of the centrifugal clutch. Again, this provision makes it possible to restart an engine which has accidentally been stopped and also to use it as a brake when descending a hill, even from rest. The complete change mechanism, incorporating this clutch, is briefly described under gearboxes.

It may be recollected that at the last Commercial Vehicle Show the Daimler Company showed a centrifugal clutch as an alternative to the fluid flywheel to meet the wishes of a few users. This component had segmental weights, faced with brake lining, expanding against the control of garter springs to engage a drum on the gearbox drive shaft. A feature of the Daimler arrangement was the fitting of a roller-type free-wheel between the engine and the drive shaft which ensured that the engine would at all times be driven by the vehicle on the overrun, as long as the Wilson box was not in neutral.

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GEARBOXES

Interesting Developments in Semi-automatic and Automatic Control

PRACTICALLY all gearboxes now use Warner-type baulked synchromesh on second, third, and top speeds. The gearbox of the new Humber Snipe is rather unusual in having synchromesh on all four speeds. In three-speed gearboxes, which are in any case somewhat rare, first-speed engagement is by sliding wheel, a notable exception to this practice being the Standard Vanguard, which has synchromesh on first speed also.

The Rover Company continues its practice of fitting General Motors-type baulked synchromesh, with large cones, to third and top gears only, second speed being engaged by an internal-toothed dog clutch and first speed by a sliding wheel. It should not be inferred that this practice implies any inferiority in gear-changing performance. It will be recalled that the Rover car has, as always, a free-wheel incorporated in the back of the gearbox and available on all speeds. In our opinion, this provides a more satisfactory change down into second speed on a steep hill than the synchromesh devices in common use, hardly any of which have sufficient torque capacity on the second-speed cones to give the rapid synchronization required for an emergency change. With a free-wheel, an instantaneous change can be made without any possibility of an overrun jerk. Free-wheels are not perhaps, particularly suitable for traffic driving, but it must be remembered that the Rover cars have always incorporated a control that enables the driver to lock the free-wheel if circumstances make it desirable.

While on the subject of free-wheels, our approval of the roller-type free-wheel clutch fitted by the Bristol concern to the first-speed wheel of their four-speed gearbox may be reaffirmed. First speed, admittedly, is seldom required, but for a driver taken unawares by a precipitous hill it is consoling to know that the lever can be slammed into first without thinking about engine speed, and in the knowledge that the engine will take up the drive perfectly smoothly. On a car of semi-sporting type, high-geared and with close ratios, first speed can then be used in dense traffic without the rather violent momentary deceleration which occurs on releasing the accelerator.

In spite of the great popularity of automatic transmissions in America, it should be noted that most trans-atlantic firms offered conventional three-speed boxes as an alternative, with an automatic overdrive of the epicyclic type as an optional extra.

No less than three Continental cars were shown with five-speed synchromesh gearboxes. The Lancia Aurelia, shown last year, is joined by the Fiat 1900 and the Pegaso.

Fiat employ a normal type of gearbox, giving direct drive on fourth speed, fifth being a geared-up overdrive. As mentioned in the notes on clutches, the Fiat is unique in having a fluid flywheel in series with a dry-disc clutch for gear-changing.

In the Pegaso, which has a 2·5-litre engine of extremely high performance, the aim is clearly at a car which can be used for some classes of competition work. Ratios are very close, the reduction from top to fourth being 1·33, from fourth to third 1·33, and from third to second 1·44. Mounted as a unit with the spiral-bevel rear wheel driving assembly, the gearbox comes behind the differential housing and has its driving shaft below the driven one which carries the bevel pinion at its front end. All speeds are indirect and pump lubrication is provided. Central change is by a lever close to the driver's seat, coupled by a sliding and rotating tube to a laterally extending selector arm picking up the striking rods, the mechanism being enclosed in a box coming just in front of the differential housing.

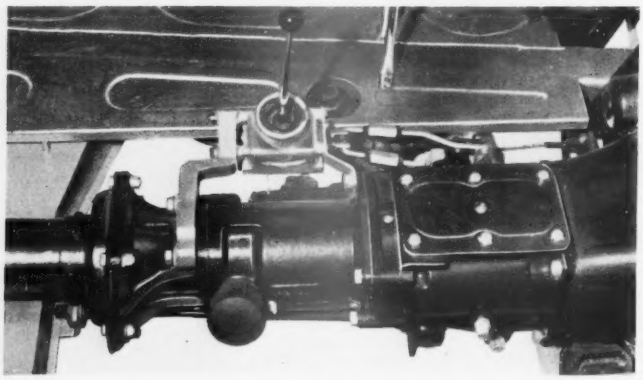
It will be remembered that the Lancia Aurelia gearbox is also indirect on all gears, the practice being in any case nearly standard on cars specially intended for varying kinds of competition work and often using fourth and third speeds as much as, or even more than fifth speed.

It is interesting to note, however, that the four-speed gearbox of the Renault 2-litre is also indirect on all gears. Though this may be considered a normal touring car, with a good power-weight ratio, third speed is remarkably close to top gear, the reduction being only 1·23 : 1. No doubt the fact that third speed, which has an overall ratio of only 5 : 1, is intended for use for prolonged periods, has influenced the designer in employing an indirect box, which would be quieter and slightly more efficient under these conditions than an orthodox direct-drive unit.

Another deciding factor was probably the mounting of the rear wheel driving gear on the frame which, by eliminating propeller-shaft movement, allows a very low floor line without a tunnel. The indirect gearbox, which is assembled as a unit with the engine, provides a power outlet which is about three inches lower than that of a direct-drive box and also gives a flat floor at the front seats.

The increasing use of multi-speed gearboxes and overdrives is tending to a rather remarkable state of affairs. Many cars are now geared so high on top, or overdrive if the word is preferred, that wind resistance never allows the engine to reach the peak of its power curve. At the same time the next lower gear is sometimes low enough to take the engine *past* the peak of the power curve before balancing out. While of little interest to any but very fast drivers, the fact remains that some modern cars have *lower* maximum speeds than they would have had with a normal top gear of a ratio intermediate between those used at present. No hard and fast rule can be laid down, and, in the case of some modern cars with remarkably low resistance coefficients full engine power can actually be developed with a distinctly high top gear. The Renault 2-Litre saloon, for example, has a coefficient of only 0·25, which is excellent.

Daimler continue to use the Wilson box with fluid flywheel, and top gear as an overdrive with preselection by a lever mounted on the steering column and operating the selector camshaft by ball-jointed rodwork. On the new Armstrong Siddeley Sapphire the operating struts of the Wilson gear-



Change-speed control on Nash-Healey

bands are selected by solenoids, without the intervention of any camshaft.

Each solenoid is wired to a contact on a switch carried on the steering column and operated by a small lever moving in a gate, so that its position can be felt without taking the eyes off the road. Preselection of the gear closes the appropriate contact, the circuit being completed by another switch, common to all solenoids, operated by the depression of the gear pedal.

Column control of the normal synchromesh gearbox is standard on all but the smallest cars, with the notable exception that any car in the strictly "sporting" class will hardly sell without what one might call "floor" control.

Ford Anglia and Prefect continue the lever direct on the gearbox, and the same can be said for Morris Minor and Austin 7. Jaguar, rightly in our opinion, continue the "remote" control with the lever carried by a rearward extension of the gearbox. A similar positioning is continued on Riley and Alvis models. The new Spanish Pegaso, as becomes what is almost a racing car, also has the gear lever mounted on the floor.

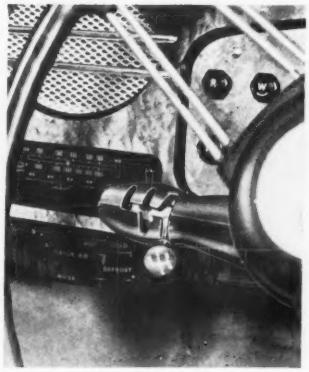
The preference for this arrangement on vehicles driven at high speeds and sometimes requiring forceful and rapid changing is understandable, but ingenious devices have to be employed on some sports cars to convert to "floor" control gearboxes originally designed for operation from the steering column.

On one of the Healey models for example, the change-speed lever oscillates in a box carried by a bracket bolted to the rear of the overdrive casing of the Warner three-speed gearbox. Two short sliding rods are alternatively picked up by the selecting finger, being connected by short adjustable rods to the two hanging levers on the striking cross-shafts of the three-speed gearbox.

The same problem is tackled in a slightly different manner on the Allard Palm Beach chassis: on this model hanging levers on the gearbox are rod-connected to levers on two concentric shafts carried by a frame cross-member at the rear of the gearbox. The shafts run across to the right of the centre line, where fingers on them are alternatively picked up by the gear lever.

Semi-automatic and automatic transmissions

Automotive Products Ltd are offering the Manumatic transmission, the clutch of which is described elsewhere in this review. This is *not* an automatic transmission inasmuch as it does not initiate gear changes of its own accord, but merely carries out automatically the movements of the clutch and throttle necessary to complete the change of gear in a normal synchromesh gearbox after the driver has moved the change-speed lever and meshed the next gear. Though the clutch pedal is left in position, so that it can be used in case of any failure of the automatic mechanism, normally the driver does not touch it.



Armstrong Siddeley control lever on steering column

No alterations to a standard gearbox are required, though a preference is expressed by the makers for a gearbox with synchromesh on all four speeds. The basic components comprise a special clutch, already described, capable of operating centrifugally but also under overriding control by a vacuum servo operating normal withdrawal gear. A vacuum reservoir is provided to ensure operation under momentary full-throttle conditions, and an electrically operated control valve unit applies the vacuum to the clutch servo and to a small servo which can, under certain conditions, take charge of the throttle opening, irrespective of what the driver is doing to the accelerator pedal.

The control valve unit is electrically connected to a switch on the gear lever column tube, to a switch on the hand brake lever and to a synchronizing switch within the clutch which closes a circuit as long as the clutch shaft is running faster than the flywheel. The throttle is also mechanically connected to the clutch operating servo.

When the gear lever is in neutral the gear lever switch is closed and, with the engine ticking over, the clutch is automatically disengaged by the springs restaining the centrifugal weights.

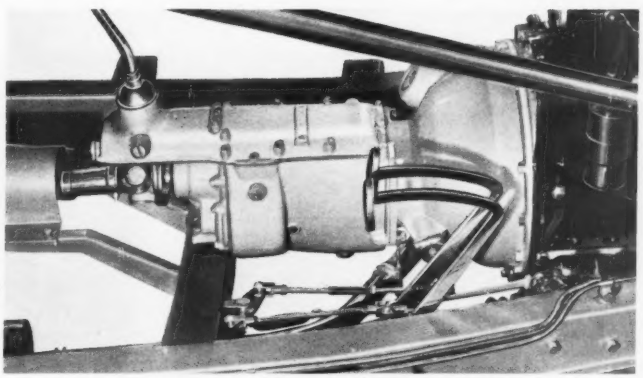
The clutch is also positively withdrawn because the closing of the gear-lever switch operates the control valve to admit vacuum to the clutch servo.

On moving the gear lever and engaging first or second gear the gear-lever switch is opened, allowing the valve in the control unit to close, thus putting the vacuum servo out of action. Since the engine is, by assumption, just ticking over, the clutch does not engage until the driver accelerates. Engagement begins at 850 r.p.m. and is complete at about 1,200 r.p.m.

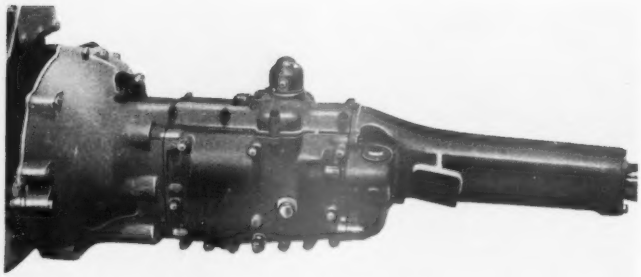
On the next upward change the centrifugal clutch remains engaged but, as the lever is moved across the neutral position the gear lever switch closes, to operate the control valve solenoid and cause it to admit vacuum to the clutch servo, which withdraws the clutch. The throttle is also closed by mechanical linkage with the clutch servo.

When the lever is moved into the next gear (effecting synchromesh engagement) the gear lever switch is opened. This causes the control valve solenoid to close the clutch vacuum valve and allows the clutch to re-engage. At the same time the movement of the clutch linkage cuts out the throttle over-riding control and returns the throttle to the control of the driver by the accelerator pedal. The car then proceeds normally in the next higher gear. Subsequent changes repeat the process.

A downward change is initiated by movement of the gear lever into neutral. This closes the gear lever switch, and gives clutch withdrawal and throttle closing as for the upward change. Then the lever movement is continued into the next lower gear and normal synchromesh engagement is made. This causes the gearbox driving shaft to run faster than the engine flywheel and in over-running it carries with it the ring of the synchronizing switch, which is driven by light friction. This relative movement closes a switch which energizes



Alvis gearbox and clutch operation linkage



Bristol gearbox

the throttle-opening servo, whereupon the engine speeds up until synchronization is reached and slightly overpast, opening the switch. The throttle opening servo then gives up control, the clutch engages and the throttle control is, so to speak, handed back to the driver. Engine and gearbox shaft have been synchronized, and the clutch therefore engages without shock and the car proceeds with whatever throttle opening the driver had set with his foot before changing gear (unless he had moved his foot during the change, which is quite unnecessary and undesirable).

All the driver need do, for either an upward or a downward change, is to move the gear lever to the speed desired. During the process of changing, the mechanism takes charge of the clutch and the throttle, but when the clutch is engaged again the driver has full control.

There are in addition, other safety devices, which we have not space to describe in detail, provided for certain contingencies. We would however, add that the normal clutch pedal is retained, and by pressing on this and releasing a catch operated by Bowden wire from the fascia board the thrust plate of the clutch is allowed by the withdrawal gear to move forward of the normal position. This ensures that the clutch is engaged no matter whether the bob weights are flung outward or not. A tow start of a stationary engine can thus be made. Furthermore, if the engine is used as a brake during the descent of a steep hill, its retardation is not lost if the vehicle is brought to a standstill, a condition under which the unassisted centrifugal action would let the clutch go.

A feature of the Manumatic control is that it can easily be applied to an existing car without serious modification to any part except the replacement of the original clutch by the new unit and the addition of the switches, control unit, servos and vacuum reservoir. In contradistinction to some automatic transmissions, the Manumatic never changes gear of its own accord and against the wishes of the driver.

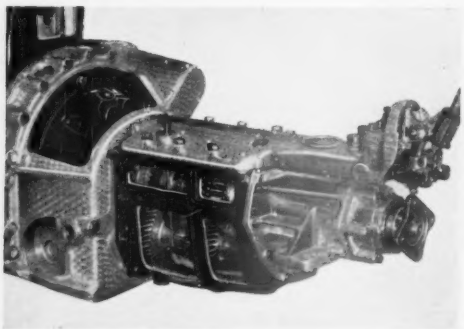
Considerable modifications have been made in the Hobbs four-speed transmission. This, it will be remembered has two hydraulically engaged and centrifugally controlled disc clutches in the engine flywheel, coupled to an epicyclic train with three hydraulically-operated disc brakes. In the original design it was necessary, at one point in the gear-change, to release one clutch and engage the other and some of the parts had to be somewhat violently accelerated in the process. A redesign of the epicyclic train has made it possible to obtain the three lower gears merely by engaging one or other of the brakes, one engine clutch being engaged all the time. Top gear involves the releasing of the third gear brake and the engagement of the second clutch, the first one being still engaged. Reverse is obtained by engaging the second clutch only and holding what was the first speed brake.

Starting is always by engagement of one of the clutches, the oil pressure being built up as the engine speed rises from the tick-over by a centrifugally operated valve that closes the escape port. All clutches and brakes are of the single disc type, with moulded facings, operated by pressure plates moved by annular synthetic rubber diaphragms. Two oil pumps are provided, one driven by the engine and one by the output shaft.

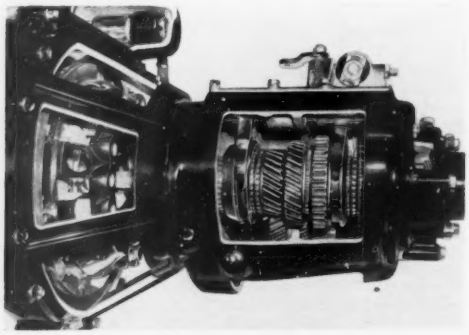
The original gear was intended for manual control by actuation of a small lever working a piston valve. The firm can now offer either fully automatic control, or an automatic transmission with overriding controls on any desired speed, to prevent undesired upward changes. No separate clutch pedal is required, though, for those who desire it, the effect of a clutch can be given by a pedal-operated valve releasing the operating pressure.

There is no doubt that the British automobile industry is taking a keen interest in automatic transmissions, especially in view of the almost universal adoption of one system or another in America. Our export market is beginning to be affected by the fact that a generation of users is growing up in the U.S.A. who do not know how to drive a car with an ordinary gearbox.

One of the most interesting items of news released during the Show was to the effect that Rolls-Royce are fitting a modified form of the General Motors Hydramatic transmission to export models. Our readers will remember that this mechanism, in its original form, comprises a four-speed epicyclic gear with gear trains arranged in series and with a fluid coupling which though, for convenience, is contained in the engine flywheel, actually couples together two parts of the gear train so that it only transmits a part of the



Jaguar gearbox and clutch



Gearbox and clutch of Humber Super Snipe

engine torque. The remainder passes by solid connection to another part of the train.

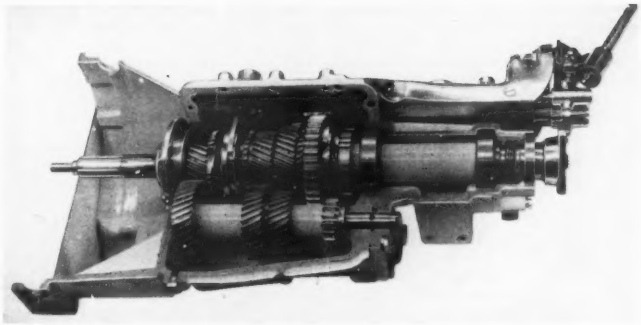
Changing is by multiple-disc clutches and brakes operated hydraulically under elaborate automatic control based on vehicle speed and throttle position. In addition to a manual control giving reverse and neutral positions, two drive positions are provided. In "low" range the mechanism is only automatic over first and second speeds, in "high" range all four speeds are under full automatic control.

Under average American conditions, which mainly involve rapid acceleration from rest at traffic lights and high-speed driving on wide roads without serious hills, the Hydramatic transmission gives effortless control and reasonably smooth acceleration. Even so an expert driver with a normal synchromesh box can do as well, or even better.

But on winding, undulating, hilly roads, especially with a fair amount of traffic going in both directions at varying speeds the performance can be extremely disappointing. A particular case we have in mind is an Austrian mountain pass, climbing for miles on end to an ultimate altitude of some 8,000 feet, the road being well engineered, with ruling gradients not exceeding 1 in 12 and many hairpins bends of fairly small radius.

Several ascents and descents of this pass by a powerful American car with Hydramatic transmission brought out three points (1) the car was, during momentary checks from slower lorries ahead, frequently passed by nearly everything else on the road, including Volkswagen and light 'buses. (2) The radiator boiled so badly that several stops for replenishment were required. (3) The brakes overheated to an extent that called for several stops to cool down.

The car was in perfect condition, had a high power-weight ratio and the automatic gearbox was functioning exactly as its designer intended. But the fact of the matter is that all the defects mentioned were entirely due to the fact that the transmission *was* automatic. Had the gearbox, with the same ratios, been under direct driver control none of the troubles would have occurred and the performance of the vehicle would have been greatly improved



Arrangement of gears in Jaguar-Moss box

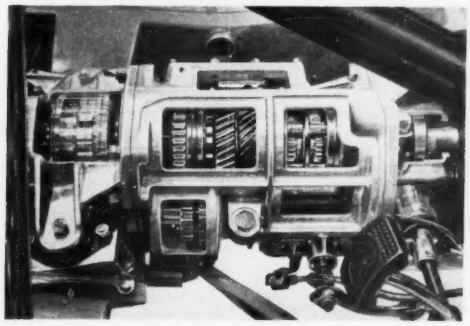
As the car was easily capable of climbing the gradients on 3rd gear it was kept in "drive" range. When the car was travelling fairly fast uphill on third speed and was momentarily checked somewhat by a slower vehicle in front, on release of the accelerator, the automatic mechanism, changed into top gear (which is a particularly high ratio on this car). When an opportunity seemed to offer of passing the car in front (traffic being fairly dense in both directions) the engine would not respond quickly enough to the accelerator, since the engine was turning over slowly, had to be speeded up and the automatic change made to third speed before the car "got going". In the meantime a car with an old-fashioned gearbox, holding the particular gear (either 3rd or 2nd) which the driver found most suitable, could pass both vehicles.

Again, the frequent changing into top gear when the accelerator was released, say when negotiating a bend, quite apart from traffic checks, meant that, on the average, the fan speed was much lower than it would have been if third speed had been held all the time. At the high altitudes involved this was sufficient to cause heavy boiling.

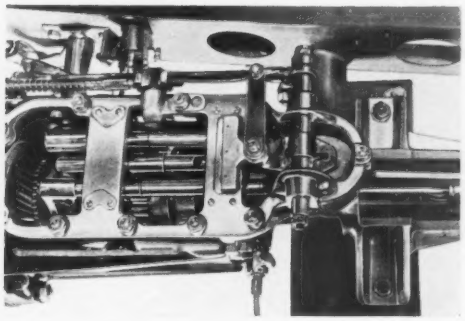
During the descent of the pass, the automatic transmission engaged top gear all the time, making the engine practically useless as a brake. Temperature fading soon occurred and several stops had to be made to cool the brake drums. The only remedy available on this particular car was to put the transmission in "low" range, which holds second gear as a brake. But since this gear is a 2·63 to 1 reduction from top gear the engine braking was too much and held the car back to such an extent that the throttle had to be opened to prevent being overtaken by normal cars. After all it should not be necessary to use petrol to drive a car downhill.

About a year ago General Motors realized that improvement was desirable, and Hydramatic transmissions, including, of course, the modified form used by Rolls-Royce, have now been given two alternative control lever positions in the "drive" range. That marked 4 on the Rolls version corresponds to full automatic control from bottom to top, but in position 3 the transmission will not change into top gear under any circumstances unless the vehicle speed exceeds about 70 m.p.h.

This comparatively minor modification entirely removes all the objections just disclosed. Third speed being held, engine speed and fan speed are higher, acceleration is instantaneous and the same gear is available as a brake and is also an entirely suitable ratio for des-



Rover gearbox



Selecting bell-crank on Singer 1500 gearbox

cending a very long, but only moderately steep hill at fairly high speed.

The Rolls-Royce Co. offer the Hydramatic transmission (modified to include the Rolls friction brake servo and the oil pump for ride control of the rear shock-absorbers) on export models only. They leave the axle ratio at 3·73 to 1 and the overall ratios are :— top 3·73 ; third 5·37 ; second 9·80 and first 14·1. Corresponding ratios when the synchromesh gearbox is fitted are :— 3·73 ; 5·0 ; 7·52 ; 11·11 to 1.

No torque converters were to be found on any of the British or Continental cars at the show, but all the types that have been described in the *Automobile Engineer* were shown on one or other of the American vehicles exhibited.

It was freely rumoured that certain British makers of high-performance "sporting" cars are seriously considering the fitting of torque converters for the American market. While we feel sure that most English drivers of this class of car would prefer a close-ratio four-speed synchromesh gearbox, it would seem that the Borg-Warner transmission, as fitted to the Studebaker car, would be the best compromise for the American market on a car with a really powerful engine —say 120 h.p.—intended for use by enthusiastic and knowledgeable drivers.

This transmission, it will be recalled, gives solid direct drive on top gear. On a change down, the locking clutch is released and the power then passes through the torque converter and through an epicyclic reduction of about 1·3 to 1·4 to 1. In effect there is a close-ratio third speed, with the torque converter working as a coupling with very little loss, but available to give torque multiplication should the load demand it.

In our opinion any "sporting" high-performance car stands or falls by its efficiency on third speed, the gear on which all high-speed acceleration is done and the obvious gear for speed hill-climbing where the nature of the road will permit it. We think it fair to say that the Borg-Warner transmission, working at say 1·4 reduction, would transmit about 20 h.p. more to the back wheels, under such circumstances, than a simple torque converter without epicyclic reduction. This not merely because of the losses in the converter (which are by some people exaggerated) but because the torque converter without reduction holds down the engine speed to a figure that seriously limits the power developed.

PROPELLER SHAFTS

Minor Modification on Established Designs

USE of the Hardy Spicer needle-roller joint is practically universal. It is becoming increasingly common to mount the shaft with reversed splines, the sliding member being supported by a thin-wall plain bearing in the gearbox rear extension. Sealing is by normal synthetic rubber assemblies, and very little trouble is now experienced from the combination of rotational and sliding movement that occurs at this point. Telescopic dust shields are always fitted. Furthermore, the outer surface of the sliding sleeve is plunge cut ground to avoid feed helicals likely to cause oil pumping.

Considerations of floor line and shaft tunnel clearances often preclude the use of rubber joints, such as the Layrub, which, if intended for big angular movement, have a larger diameter than the needle-roller alternative. Layrub joints are used on the Jowett Javelin. A smaller type, with all six driving pins on one member, is fitted to the Renault 2-litre, on which the bevel drive assembly is carried by the frame, so that propeller shaft angularity is negligible.

Spring-supported Hardy Spicer intermediate bearing on Rover chassis

Rubber is frequently used for the front half of a divided shaft, the Fiat 1900 for example has a coupling behind the gearbox consisting of a three-lobe driven member fitting in a rubber member that engages three internal lugs on the driving half.

Metalastik Ltd. have taken a licence for the manufacture of a special rubber universal joint developed by the rubber bonding department of the Italian Pirelli Company. This is designed to work at moderate angles and comprises six or eight radial vanes, made from two pressings placed back to back around the coupling bolts. These pressings are joined by cylindrical rubber distance pieces bonded to the vanes to form a hexagonal or octagonal assembly.

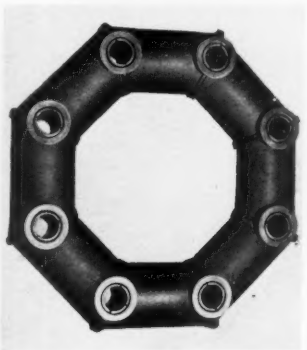
For this component, an interesting method is employed to give compression preload to the rubber. The joint assembly is made to a larger pitch circle than that of the coupling bolts, but is compressed at the factory to suit the smaller dimension. It is retained by a thin steel strap which is cut off with shears after the propeller shaft has been assembled. The system gives considerable elasticity and therefore requires some kind of centering device when used on a fast-running shaft.

The Hardy Spicer intermediate bearing is very popular. As may be recalled, it consists of a ball-bearing housed, with suitable seals, in a short tubular shell to which a laterally-extending plate is welded. This is carried by opposed rubber bushes on two bolts picking up lugs on a frame cross member.

On the Rover chassis, it was noted, these bushes are purposely made rather soft and a compression spring is mounted underneath the plate. This arrangement balances the dead weight of the shaft and thus permits of the rubber bushes starting from zero in absorbing propeller-shaft vibrations.

On a much reduced scale, the Rover arrangement follows the lines of the Bentley intermediate bearing, which is carried by hinged arms and is balanced by a spring that permits very considerable displacement before the shaft settles down on its running axis. The Bentley arrangement is primarily intended to absorb the lateral forces set up by shaft angularity when transmitting torque.

The intermediate bearing on the Renault 2-litre is quite elaborate. The housing of the ball bearing has gudgeons carried in rubber bushes in brackets bolted to a spring steel blade over a foot long, lying flat under the shaft at right angles to its axis, and carried at its ends by rubber grummets picking up a body floor cross-member.



The rubber member of the Metalastik-SAGA universal joint

REAR AXLES

Semi-floating Axles and Hypoid Bevels still Predominant

USE of hypoid bevels is now such standard practice that exceptions are the more remarkable: apparently the Ford Anglia and Prefect and the Rover models were the only examples of spiral bevels in the Show. This is no particular reflection on the firms concerned, since, given good design, a spiral bevel can be practically as quiet as any hypoid, while it has the very great advantage that it is not so susceptible to adverse effects from lubrication with unsuitable oil. Banjo axle construction is still widely employed. For example, the Austin 7 rear axle is of this type. On the other hand the redesigned Riley axle has a Nuffield type cast centre casing split in the vertical and longitudinal plane.

Salisbury Transmission Company have brought out a new small axle, type 6HA, which exactly follows the existing standard practice of this organization as far as the one-piece casing with half-buried differential bearings is concerned. End thrust of these bearings is taken on a continuous facing machined on the inner ends of the sleeves that take the side arms, and not, as is more common, partly by the bearing caps.

The new axle has a slightly higher torque rating for its size than the earlier models, and the differential box is slightly larger in proportion to crown-wheel diameter. This is possible since the crown wheel is attached to the flange, integral with the box, which backs it up, by setscrews in blind holes. Thus the inwardly projecting flange on the crown wheel to take the previous through-tapped holes can be dispensed with, and the overhang of the flange carrying the crown wheel is reduced. The increased stiffness thus afforded has enabled the rating of the crown wheel and pinion to be raised.

While the semi-floating axle is the most common arrangement, it is interesting to note that the smallest car in the Show, the Austin 7, and also one of the largest cars, the new Humber Snipe, both have three-quarter floating axles.

In the Humber axle the differential shafts have integral flanges and the double-row ball bearings are secured on the axle noses and housed in rings secured by bolts to the inner faces of the differential-shaft flanges. As in the similar Austin arrangement, fracture of a differential shaft leaves the wheel still secured in position.

A rather surprising number of cars now employ back axles of the De Dion type or with independently sprung wheels. Examples of the former are the D.B.3 Aston-Martin, the Allard V.8 and the Spanish Pegaso, while among the independently sprung cars must be reckoned the Lancia Aurelia, the Renault 750 rear-engined car, the Renault 2-litre front-engined vehicle and the Lagonda.

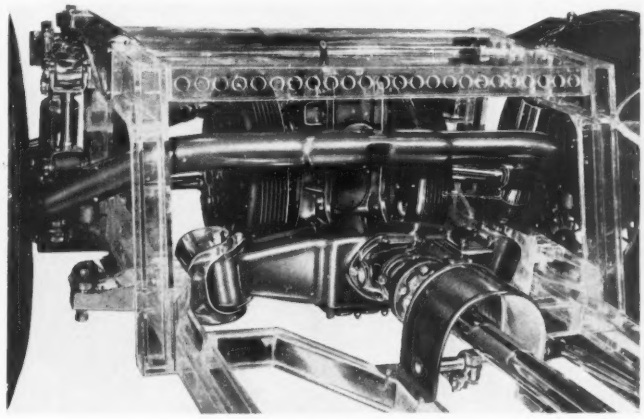
Aston-Martin, Lagonda and Allard have differential housings of Salisbury manufacture that are standard back axle centres modified by the omission of the side arms and the provision of

Salisbury axle and shock-absorber mounting on 3-litre Alvis

housings for an additional ball bearing on each side to support the short half-shafts and steady the brake drums which they carry.

On the Lancia Aurelia and the Pegaso the differential housings are combined with the five-speed indirect gear boxes. The Pegaso box comes behind the differential. In both these cars the brake drums also come on the differential assembly, but on the Renault 2-litre the brakes are carried by the trailing arms of the suspension.

The advantages of the De Dion axle or independent springing on cars of the racing class are well known, not the least being the avoidance of wheel lead unbalance due to propeller shaft torque. It is however, an expensive arrangement to fit to a quantity-production pleasure car such as the Renault 2-litre. Pegaso use Mechanics-type universal joints, the others, except Lancia, fit Hardy Spicer needle-roller shafts, with the usual slip-spline in the middle. Lancia take care of the sliding by a pot-type universal at the inner end.



Lateral guide of De Dion axle on Pegaso chassis

FRONT SUSPENSION AND STEERING

Many Different Forms are Still Employed

ALTHOUGH wishbone and coil spring is the most widely used form of front suspension, the industry is very far from finality in the matter. This is shown by the fact that at least ten different forms of front suspension were shown by firms of real repute and experience.

Beginning with changes of policy as perhaps specially significant it should be recorded that two firms formerly using torsion bars have gone over to coil spring and wishbone on some models at least. Previous Armstrong Siddeley cars had torsion-bar front springing under Citroen licence, one of the features of which is the use of spherical joints for spring articulation and for steering at the same time, in a manner similar to the arrangement on the Jaguar chassis. Special to the Citroen patent was, however, the use of taper roller bearings within each ball and carried on co-axial stubs on what is virtually the king-pin axis. These permit the steering movement to take place without turning the balls in their sockets.

Incidentally another instance of a double-purpose ball joint at the outer ends of front suspension linkage was found on the stand of Automotive Products, who showed the Thompson suspension ball joint. Two of these are, of course, used. The lower one comprises a ball hanging on a taper shank and working in a socket formed in the lower link. This arrangement, which reduces very considerably the full area of the ball available for load carrying, is better than might be supposed from the fact that only articulation movement is taken care of on the spherical surface. Steering rotation turns the ball on its shank, and vertical load-friction is dealt with by a row of bearing balls running in races grooved in the lower face of the ball and the upper face of a flange on the shank.

The upper ball joint is without this provision, but is spring-loaded from below like a steering connection. It can therefore take up all play in an otherwise slack member and also introduce a certain amount of friction in the steering motion, which might otherwise be too free for steadiness.

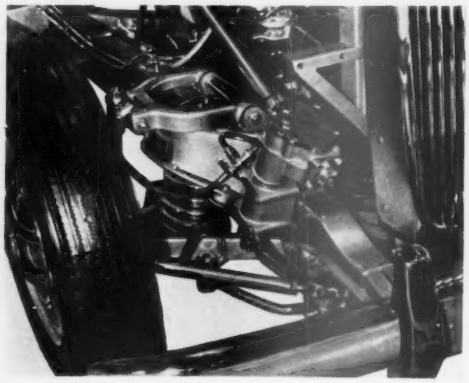
The Armstrong Siddeley coil and wishbone suspension has the upper and lower arms made as separate stampings, with a pressed-steel spring pan secured to the lower pair by bolts. The outer joints of both wishbones are of the threaded type, and, for convenience of assembly, the spindle forming the inner fulcrum for the upper wishbone has a plain bearing at one end and a threaded one at the other. A unique feature is the use of Metalastik Ultra Duty bushes for the inner ends of the lower wishbones. In these the rubber is bonded to both inner and outer sleeves and is further preloaded after vulcanization by compression of the outer steel sleeve. The bush is therefore capable of carrying heavy loads. Nevertheless, it is somewhat surprising that rubber is used at this point without the flanges, either pre-moulded or forced up on assembly, that are a feature of all other systems and which give much more rigid end-location than a parallel bush.

We understand that by cushioning end-shocks this arrangement tends to reduce body-rumble. However, it might well be argued that to provide so much of the resilience in what is, after all, supposed to be a geometrically accurate basis for the steering linkwork is undesirable. Nor should it be forgotten that, in wishbone suspensions in which brake torque is almost entirely taken by a rearward reaction on the lower and a forward reaction on the upper wishbone, the end-loads on the lower bearings are more than double the brake drag at road surface and amount to about a ton on a large car when it is heavily braked.

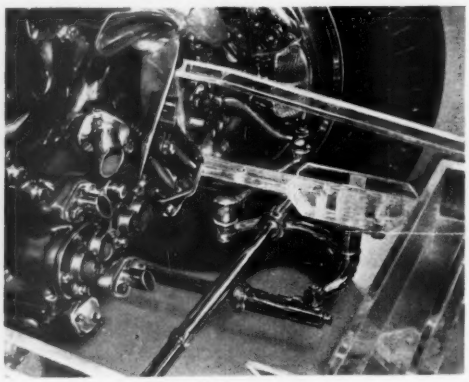
The Armstrong Siddeley suspension is laid out with a trailing dihedral angle of 25 deg each side. It is assembled on a massive box-member with integral brackets to take the upper ends of the springs; the telescopic shock absorbers come within and can be removed without disturbing the springs.

Steering linkage is reminiscent of American practice, the dihedral setting allowing the rearwardly placed track rods to converge with accurate geometry on two ball joints on a rearwardly extending intermediate lever pivoted on the cross member. The whole assembly is attached to the frame side-members by seven bolts on each side.

Wishbone and coil spring instead of torsion bars has also been adopted on the 4-44 Wolseley. In this case the lower wishbone is on the same lines as used by the firm when a torsion bar is employed. It consists of a laterally extending single stamping that has Metalastik Bonded cone tube bushes at both frame and king-pin ends and bolted to it, on its centre line, a pan to take the spring. Fore-and-aft loads are taken by a radius rod running at 50 deg to a joint that comprises a pair of opposed rubber washers located on the axis of the inner joint of the load-carrying stamping. In comparison with the original Wolseley design, the new scheme is better in that the absence of the torsion bar has allowed the radius rod to be made longer and the joint to be put in the best position, which was formerly occupied by the torsion bar.



Steering and front suspension of 3-litre Alvis



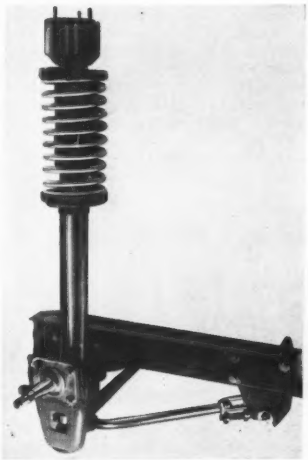
Steering linkage on Pegaso chassis

The coil springs are set at an angle of about 30 deg and their lower ends can therefore be brought closer to the outer end of the suspension arm than is possible with a vertical layout. Telescopic absorbers come inside the springs, which take a bearing at their upper ends on a fabricated box-section cross-member that appreciably reinforces the front end of the monocoque body structure.

The rack-and-pinion steering comes under the locally flattened engine sump just in front of the cross-member by which it is carried. An advantage of this low-placed mounting is that the track rod arms come approximately in line with the lower wishbone joints. Therefore the rods can, and with geometrical accuracy, be much longer than is common on rack and pinion layouts, to give a beneficial reduction in the angularity of the joints.

Particular significance should not be attached to these two changes from torsion-bar to coil spring, since, in general, there is little to choose between the two systems. The Volkswagen is one of the few examples in which the whole highly ingenious layout, with a tubular backbone frame, is based on the use of torsion bars, which, in this particular case are probably cheaper than any alternative. As fitted to orthodox cars longitudinal torsion bars are probably just as expensive and very little lighter than coil and wishbone. Unless "handed" and prestressed the torsion bar must work at lower stresses than a coil spring which has, for the last 50 years, been prestressed as part of the normal manufacturing process.

One advantage of the longitudinal torsion bar may perhaps have been overlooked by some designers. According to the length of the suspension arms, a torsion bar suspension relieves the forward part of the vehicle, back to the torsion-bar anchorage, of a considerable amount of the torsional strains set up by momentary unequal wheel loading, the figure amounting to about 35 per cent reduction in some cases. It must, however, not be forgotten that nearly all modern cars, with restricted wheel travel and flexible springs, sit down on the front bump rubbers when maximum braking is suddenly applied. The torsional strains due to this are, of course, transmitted to the car structure at their full value.



Ford front suspension with Metalastik joints

For eliminating "road roar" and rumbles there is much to be said for the incorporation of rubber at every conceivable point of the front suspension. The Rover Company, for example, fit Silentbloc Frustracon rubber mountings under the lower ends of their coil springs. Metalastik have now developed a somewhat similar arrangement. The example we inspected has the rubber arranged in a shallow ring, and bonded to two conical pressings, in such form that it could, in addition to its function as a cushion, act as a rudimentary spherical support. Even further modification in the same direction would, we think, appeal to designers as relieving the coil spring of some of the abnormal stresses set up by the angular movement of the spring pan.

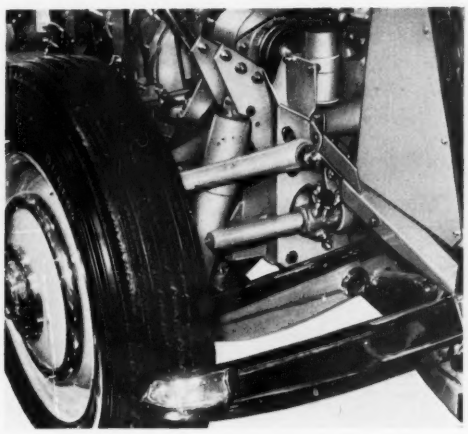
The new Humber Snipe adopts coil front suspension as a change from the laminated cross leaf spring formerly used. In striking contrast to most cars in the Show, the new Humber has not a scrap of rubber in the suspension linkage, if we except the rubber washers at the top and the rubber bush mounting of the bottom of the telescopic shock absorber.

All suspension joints are of the screwed type, as already used on the other products of the Rootes group. We understand that careful trial of rubber bushes was made during development, but it was found that the steering was less subject to oscillation and more precise with the rigid bearings. The fact that this large car is easily capable of 90 m.p.h. was also a factor in deciding the firm to make the suspension front cross-member an integral part of the frame, instead of attaching it by bolts, as in the Humber Hawk and Hillman Minx.

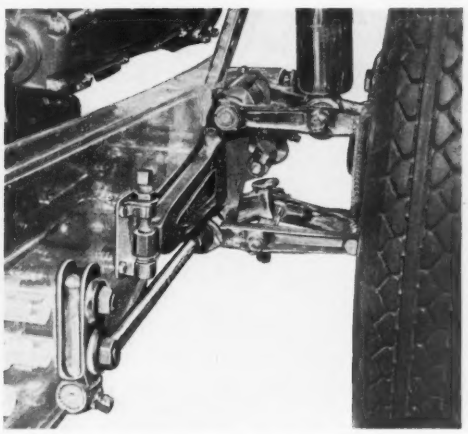
It may be remarked that on the new Humber Super Snipe the front ends of the side members are carried past the cross-member. This latter member is welded to both flanges and the web, and the large inverted cup pressings which form the upper coil spring abutments are welded to the outside of the frame members with large box-section gussets.

It may also be mentioned that on the Humber Snipe advantage has been taken of the screwed bearings to provide an eccentric centre portion to the pin of the upper, outer wishbone joint. Thus, as on some American cars, camber can be adjusted by partial rotation of the pin, while castor can be set by complete revolutions.

Another approach to the problem of providing accurate suspension linkage



Riley front suspension and rack-and-pinion steering



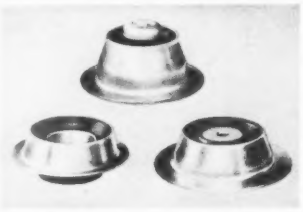
Pegaso torsion bar suspension showing castor adjustment

while yet insulating the wheels from the frame by rubber is to be found on the Vauxhall Velox and Wyvern cars, which incorporate the practice, introduced at the previous Show, of using screwed bushes throughout the suspension but attaching the whole cross-member assembly to the monocoque body by rubber cushion pads.

A frequently observed compromise was the use of rubber flanged bushes for the inner joints of both upper and lower wishbones, with screwed joints at the outer ends. The 3-litre Alvis is an example of this. On this chassis the steering box comes in front of the suspension assembly, its drop-arm spindle passing down outside the frame to carry a lever coupled to the right hand swivel by a reasonably long link and, by a cross rod to a duplicate but slave lever on the other side of the chassis. This very common arrangement greatly simplifies the production of both right- and left-hand drive chassis with the same parts.

The torsion-bar suspension on the Riley chassis remains unaltered and is notable for the considerable length of both upper and lower wishbones. The suspension front cross-member, which includes a tube fairly high up on the centre-line, passes in front of the engine and is bolted to palms on the ends of the side members. These members terminate at this point, with several welded ribs running back to strengthen the attachment of the palms. As the engine has not been placed as far forward as is now common practice the rack and pinion steering gear can be mounted fairly high up on the front of the suspension cross-member. The rack has enclosed ends, and the two long lateral track rods are ball-jointed to pins working in a central slot in the rack casing. The lower wishbone arms being fairly long, the geometrical errors consequent on the greater length of the track rods are not serious.

Quite the most elaborate of the torsion-bar front suspensions was to be found on the Pegaso chassis. On this model two torsion-bars are used on each side. The bars are naturally smaller in diameter and shorter than customary, but, since one extends forwards and the other rearwards, the front of the chassis is not relieved of any torsional strains as is the case with single bars running to the rear. There



Metalastik coil spring insulators

is no frame cross-member in line with the suspension assembly; this is rather surprising.

A steel fabrication forms the foundation carrying the upper and lower wishbone bearings. It is attached to the frame by a hollow integral gudgeon passing through the box-section side-member and secured by a ring-nut. An arm extends a considerable distance to the rear along the outside of the side member; its tail is nipped between a setscrew on a bracket bolted to the frame and a lug below it. An accommodation shim is placed between the tail and the lug. The whole arrangement gives an accurate works setting of the castor angle. Only a small angle is provided for: it would be dangerous to exceed a small amount as both torsion bars are bent out of line when the castor is altered.

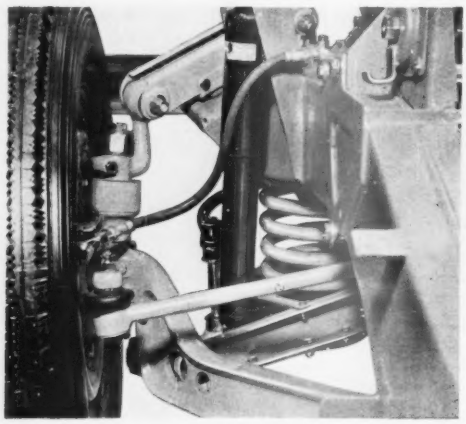
Metal bearings are used throughout the suspension, which incorporates a very large telescopic shock-absorber carried by a long, separate, upstanding bracket on the frame and pin jointed to an intermediate point on the upper wishbone. Both torsion bars pass through the bosses of the wishbone arms and are splined to a lever coming between them. The end of this lever bears on a setscrew carried by a cross-bar spanning the wishbones. A general height adjustment can thus be made, but individual torsion bars cannot be regulated.

The steering linkage comprises short rods on each side in front, ball jointed to slave levers which turn on vertical stubs attached to the undersides of the frame side members. A cross tube connects the slave levers, one of which has a bell-crank arm coupled to the steering box by a tube running alongside the engine sump.

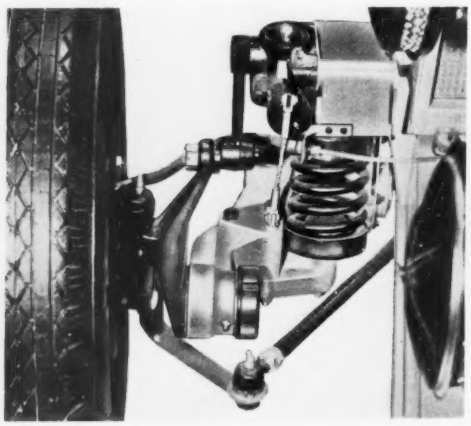
What used to be known as the Girling suspension is still employed by Daimler, and in a more refined form, by the Rover Co. Since this might by some be mistaken for a normal wishbone suspension, we are taking the liberty of mentioning it again, with particular reference to the Rover arrangement.

The king-pin column is rigidly attached to a fairly long stamped steel radius rod that runs diagonally back to a ball joint on a cross-member. Load transfer to the king-pin assembly is through a cross link made as a pressing of inverted top-hat section, the coil spring taking a bearing at an intermediate point. This cross-link is rubber-jointed to the king-pin unit, a point that must be clearly understood, since without this joint there would be, in effect, a swinging front axle. A lateral link is rubber-jointed to the top end of the king-pin column. It is shorter than the lower cross-link, and thus reduces wheel scrub and modifies the camber angle as in a normal wishbone suspension.

The vital point of the Rover (or Daimler) scheme is that the radius rod takes all the braking torque. A line joining the point of tyre contact with the radius rod ball joint runs up at



Rover front suspension



Healey trailing link front suspension with castor adjustment

about 20 deg, so that brake torque has an upward reaction on the suspension that almost exactly compensates for the transference of load from front to rear which occurs when braking. It is therefore possible to use front springs of about 10 in static deflection and a moderately restricted travel without any "nose-diving" and riding on the bump rubbers when the brakes are violently applied.

Only one objection can be raised, namely that front spring deflection increases the castor angle slightly—by about 1½ deg for one inch deflection past the static. This gives increased castor on the outside wheel when rolling on corners, and has an "understeer" effect that is in no way prejudicial to safety. So much engine chassis weight is nowadays carried by the front springs that a change in vehicle load makes only a small percentage difference to the deflection of the front suspension — additional passengers and their luggage almost balance about the back axle. Appreciable permanent alteration of the castor angle is therefore not involved in the Girling system.

As already mentioned, the radius-rod joint is of the ball type. All the other joints are of the rubber bush pattern. They are arranged so that all their axes point at the centre of the radius rod ball joint. As a result there is no cross-binding or bell-mouthing action on the joints, which work under ideal conditions and are not, for example, subject to any appreciable end or radial loading by the braking forces. This is in striking contrast to the ordinary wishbone system, which can impose end and radial loads amounting to a ton or more when the front brakes are violently applied.

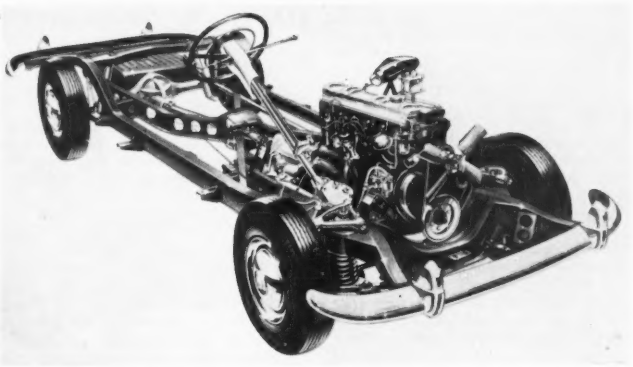
A vital factor in this loading is the spread of the wishbone bearings, especially the lower ones, in relation to the lateral distance from the inner bearing axis to the king-pin centre. We would commend the Singer 1500 suspension for having a spread-ratio well above unity; on many cars it is not more than 0·65.

There were two examples of trailing-link front suspension, the Aston-Martin and the Healey. In the Aston-Martin layout, the upper link is a double, triangulated lever based on the shock absorber spindle. The intention of this is to give maximum lateral support to the king-pin column. On the Healey this support is not provided. The shock absorber arm is a normal angle one of oval section but, against this, the lower gudgeon of the kin-pin column, which works in roller bearings in the lower trailing link, is of exceptionally large diameter and fully capable of coping with any side loads.

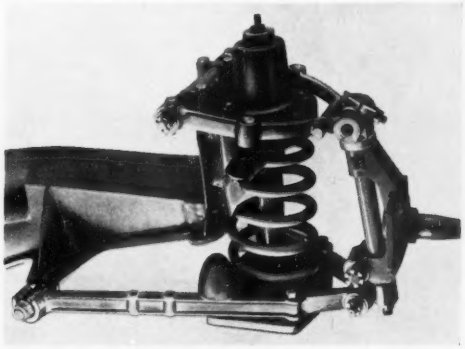
As an anti-roll device, Aston-Martin use a co-axial torsion bar joining the two lower trailing links. On the Healey the connection is by a bent external bar. In the Healey suspension the connection from the king-pin column to the end of the upper trailing link is by a rubber bush that fits on a slightly cranked pin which can be turned to adjust castor angle.

An important, if small, modification has been made in the Ford suspension. In this case suspension is by coil springs acting direct on the steering swivels, which are guided at their lower ends by a long lateral, rubber-jointed link, stayed diagonally by a rod forming part of the anti-rolling bar. The telescopic shock absorber which comes inside the spring and forms the top guide of the assembly was formerly allowed to discharge its leakage into a rubber bellows, from which it drained back into the recuperator chamber. It has been found that the bellows was liable to be cut by stones flung up by the wheel, with resulting loss of oil. A double synthetic oil seal has now been fitted to the piston rod to prevent oil leakage, and the bellows has been replaced by a metal telescopic dust shield.

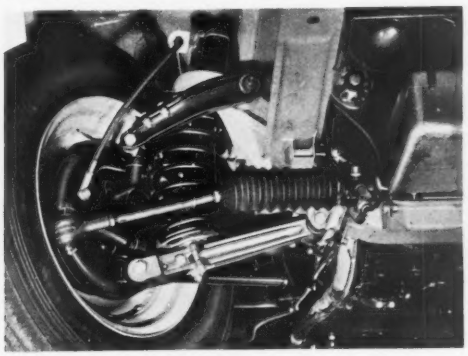
The Allard Palm Beach chassis follows normal Allard practice in employing a swinging front axle. Jointed in the centre to a frame cross-member, the two axle halves are stayed by diagonal tubes running to metal bush joints on a cross-member in front of the vehicle. Though the arrangement results in appreciable gyroscopic kick, it gives a much more accurate location of the steering swivels than many of the rubber-jointed wishbone layouts. Two metal bearings some 15 in apart replace some six rubber bushes at close centres. This system has been very successful in competition work, for which it is specially suitable.



On the Humber Super Snipe the shock absorbers at the front are mounted inside the coil springs



Armstrong Siddeley suspension with Metalastik Ultra Duty bushes in wishbone arms



Helical springs replace torsion bars on the Wolseley Four-Fortyfour

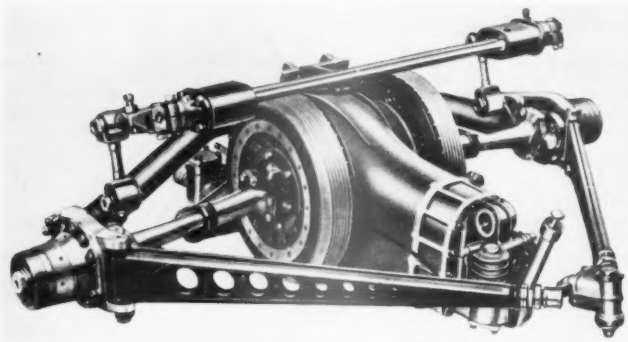
REAR SUSPENSION

Little Significant Change

SEMI - ELLIPTIC springs and Hotchkiss drive are almost universal on low and medium-priced cars, but there is a wide variety of rear suspensions on the more sporting and specialist vehicles. As exceptions to a general rule and changes from previous practice are the more interesting they will be given special attention in these notes. Torque tube construction with a single transverse rear spring remains unaltered on the Ford Anglia and Prefect, while a torque tube, in conjunction with coil springs and a Panhard rod is still used on the Buick models.

Partly, no doubt, in pursuance of a policy of rationalization, the torque tube has disappeared from the Riley axle. The well tried but somewhat complicated banjo rear axle has now given place to a Nuffield axle with split casing and hypoid bevel mounted on half-elliptic springs set horizontally. This last point is unusual in a new design, the custom now being to incline the back springs downward towards the front.

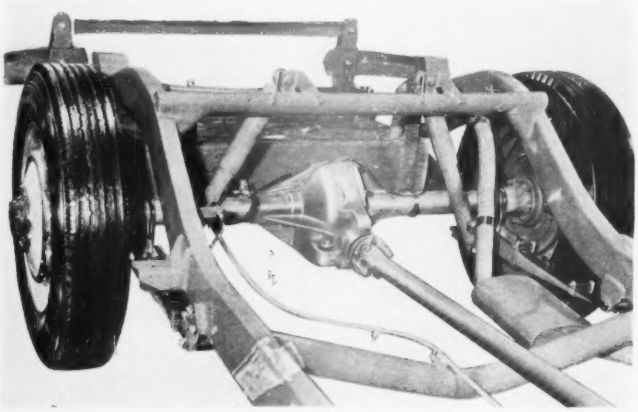
An angle of about 5 deg, for example, is the setting on the new Armstrong Siddeley Sapphire. The back springs on the latest Bentley are similarly inclined, with the rear shackles standing up from the cross-tube. Inclined springs are also used on the new Four-Fortyfour Wolseley.



De Dion axle on Pegaso, with torque triangle anchorage and torsion bar suspension

All these are in the interest of "understeer."

Some new examples of offset rear springs were to be found, especially where a rear anti-rolling bar was not used. The offset spring, in addition to reducing appreciably the rise and fall of the axle nose, has a very pronounced anti-rolling effect. Gaiters are used on many of the more expensive cars.



Riley suspension

Where they are not employed, some firms, such as Humber on the new Super Snipe, fit rubber buttons to the spring leaf tips to reduce friction.

The lever arm shock absorber is practically obsolete as far as rear suspension is concerned. Telescopic absorbers which replace it are nearly always set diagonally in anti-sway fashion. There is generally adequate room to fit absorbers with sufficient stroke, some form of rebound stop is in any case frequently used, such as the rebound strap clipped to the arms of the Snipe axle and secured at its upper end under the mounting plate of the bump rubber on the frame.

While rubber is very widely used in spring eyes, it is not yet universal. Rolls-Royce and Bentley, for example, continue to prefer bronze bushes and a "one-shot" lubrication system. We consider it a good detail feature of the Austin 7 rear suspension that a plain bush is fitted to the frame end of the rear spring shackles, since the use of a rubber bush at this point is apt to cause lateral rolling of the shackle under cornering loads.

The Silentbloc bush is the accepted fitting for the front end of a rear spring, with possibly a Harris-type bush at the rear end and in the shackle. Metalastik have introduced a new type of bush for front end attachment called the Inner Sleeve Bush.

In this a mild steel tube forms the inner member and has bonded to it a rubber sleeve, of a length rather less than the width of the spring; the sleeve is, of course, a good deal wider. The bush can be inserted freely into the spring eye. With the bar in position the inner sleeve is expanded about 0·040 in by a drift with about 3 deg taper to give the rubber a preloaded fit in the spring eye.

Of the more or less unorthodox rear suspensions the swing axle of the 750 Renault rear-engined car is already well known. This also applies to the diagonally-swinging independent rear suspension of the Lagonda, while Lancia continue their diagonally-swinging independent rear suspension. The purpose of both arrangements is to give a "toe-in" effect and counteract the loss of wheel camber on rolling which occurs with a pure trailing-link rear articulation.

The Renault 2-litre has what can best be described as a trailing-link suspension. On this the pins are set at a very slight dihedral angle, scarcely sufficient, it would appear, to make any difference. Incidentally, Renault mount the brakes on the trailing arms and not on the differential box. They have, therefore, a very pronounced tendency to counteract lift of the rear of the car when the brakes are applied. Since the trailing links are not much

longer than wheel radius and are fulcrumed well above wheel centre it would appear that violent braking would pull the back of the car down somewhat sharply and might, perhaps, cause brake shudder under some circumstances. It rather seems that the fortuitous position of a chassis cross-member was allowed to determine the height of the anchorage point, which is much higher than we think desirable.

The Allard V8 has, as will be recollected, a De Dion axle positioned by a triangulated pair of radius rods extending to the front and located laterally by a Panhard rod. On the Pegaso, the De Dion axle has converging radius rods extending towards the rear.

Lateral location is by a ball-bearing-mounted hard rubber roller carried by the axle tube and working in a curved channel formed on the front of the frame-mounted differential and gearbox assembly. In neither of these cases need the positioning of the torque balls cause any concern. As the brakes are on the differential housing in each instance, no brake, nor for that matter driving torque can come on the axle assembly, and lifting or depressing of the rear of the vehicle does not occur.

FRAMES

Developments on Well-established Lines

UNBOXED channel side members are to be found only on chassis having cross-bracing of exceptional rigidity. A classic example of this form of design is the Rolls-Royce Silver Wraith chassis. This has a rather long wheelbase and no special attempt has been made to obtain an exceptionally low floor line. The main frame can be said to be almost duplicated by the bracing, which is deeper than the side members and has its facing flanges united by fairly long parallel cover plates with outwardly forked ends. The centre of the bracing comes well back and the forward ends extend past the scuttle, the rear ends sweep up and unite with the side members at the top of the kick-up. A tubular cross member of moderate size ties the junction points together.

Four channel-section intermediate laterals tie the arms of the cross-bracing to the side members. The rear pair at the rear spring front anchorage, and the front one at a point in line with the front seat, where the side members begin to set gradually in until they are swept suddenly out and back again to envelop the coil springs of the front suspension.

In the Armstrong Siddeley Sapphire there is a lower floor line and therefore no room for very deep bracing. It has the arms running back to the top of the kick-up and carried right forward to meet the side members just behind the front suspension centre-line. The arms never come close together and the front part of the bracing could be described as an engine and gearbox sub-frame. Junction is effected by a heavy welded rectangular box with its stiffness but little impaired by the holes for the front part of the divided propeller shaft, which has its intermediate bearing carried by the rear wall of the box. As the box comes under the rear of the front seats it has been possible to raise the top in a curve of large radius; this curved top pressing is carried well over the flanges of the bracing.

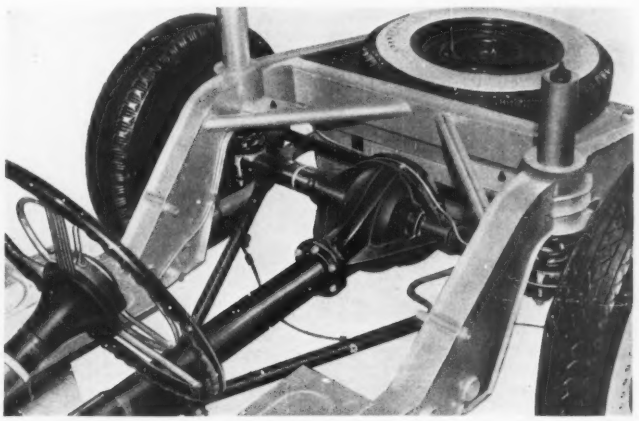
Additional support is given by two tubular cross-members that pass through the bracing arms behind and well in front of the junction box. These tubes are welded to the webs of the side members and are also welded to square plates welded to the edges of the channel flanges.

The new Humber Super Snipe also has its cross-bracing extending practically to the top of the kick-up. On this frame however, the front arms meet the frame side members fairly far back, at the point where the frame, which is a wide one, sets fairly sharply inwards. The inswept portion is reinforced by a rudimentary sub-frame that joins the bracing arms at an intermediate point, while its front end forms a tapering box with the side-members. In contrast to the Rolls-Royce arrangement, the inverted cup pressings taking the suspension coil springs are attached outside the side-members. They are reinforced with deep box-section gussets to give, in effect, a structure almost equivalent to the enveloping scheme of Rolls-Royce. A feature of the Humber cross-bracing is that the arms are fabricated of "I"-section; they converge to true centres above and below the propeller shaft clearance and are reinforced by massive cover plates. Of these, the upper one, which comes under the front seat, is curved upwards from all sides to give maximum depth at the junction point.

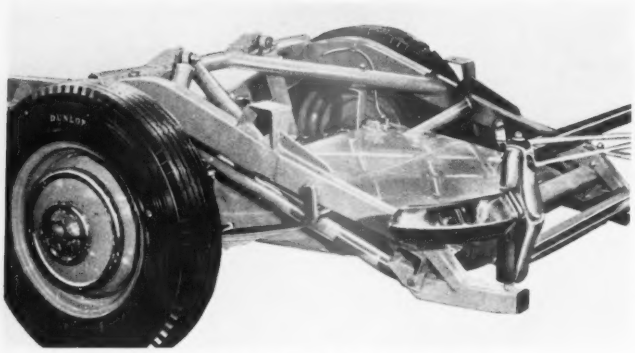
In chassis without cross-bracing, frame side members are nearly always boxed throughout. Good examples are the Rover frame, in which the several large cross-members are also of box-section, and the 3-litre Alvis chassis. The latter has frame side members of boxed top-hat section with various box-section cross-members and one inverted channel-section member at the kick-up which serves as front petrol-tank support and also neatly encloses and carries the top anchor bolts of the diagonally-set telescopic rear shock absorbers. The cross-members are attached by arc welding but the side member closure strips are attached by intermittent spot welding.

Another frame without cross-bracing is that of the 2½-litre Riley. This has the normally-boxed channel side members united by tubular members of moderate size, including one, just ahead of the kick-up, which has two rearwardly extending diagonal tubes welded to it to give local cross-bracing to a part of the frame which is, because of its sharply upswept contour, normally deficient in lateral stiffness.

The Riley chassis, in which the engine is completely behind the front wheel centre line, is unique in having its tubular front suspension cross-member assembly bolted to vertical palms welded on to the ends of the side members. The palms are reinforced by gusset brackets running some distance back along the corners



Frame of Nash-Healey



Tubular bracing of rear end of 2½-litre Riley frame

of the boxed side members.

Firms with relatively small production of some special model fabricate frames in ingenious ways. The completely boxed frame of the Nash-Healey, for example, is built up from plate, without the need for any press dies. Therefore, the very sharp rear kick-up is easily made of an exceptionally deep section at the lower angle. The coil springs fitted to the arms of the back axle fit into fabricated housings welded into the interrupted frame side members. Their curved outer walls are reinforced by three stiffening-ribs.

Tubular frames are very popular for special chassis of a sporting nature. The Jowett Jupiter is one of the best-known examples of this. For the Jaguar racing car, which has no normal side doors, a frame of enormous depth built-up in truss formation from round tubing, is used. The Allard Palm Beach chassis uses duplicated round tubes for its frame side members with the angles of the rear kick-up made by cutting and welding the tube with reinforcing cover plates fillet-welded in position. It was noticed that the makers take care to cut the ends of the cover plates at strategic points with a long bevel, an important point where a stiff tube is attached to a cover plate by what is little more than a single fillet weld.

BRAKES

Two-leading Shoe Types Standard for Front Wheels. Intensive Development of Disc Brakes

IN brake mechanisms actually fitted to production cars there has been no change in design since last Show and technical interest, therefore, concentrates on the new disc brakes being developed by both Girling and Lockheed. While extensive testing of these brakes has been going on for some time with considerable success, especially on racing vehicles, it is clear that design details are still under review. Although basic principles have been established, the two proprietary brake firms offer systems differing widely in some essentials.

Dealing first with normal internal-expanding shoe brakes, the general trend is towards increase in lining area where conditions permit. On the new Humber Super Snipe, for example, a change in rim size has necessitated a reduction in brake drum diameter from 12 in to 11 in, but since this is associated with an increase in lining width from 1¼ in to 2¼ in the lining area has gone up from 161 to 192 in² for the four wheels. Sunbeam-Talbot has made an even greater percentage increase, the previous 10 in diameter by 1¾ in brakes now being 10 in diameter by 2¼ in.

Greater attention is also being paid to cooling; ribbed drums are more common and more ventilation area is often provided in the wheel discs. On sporting vehicles gauze-protected wind scoops are common on the brake back plates, the Pegaso chassis being a good example.

Girling normally use snail-cam adjustment on front brakes; Lockheed, on the other hand, partly in the interests of reduced cylinder clearance volume, fit adjusters coming between the shoe tips and the operating pistons, which thus "start from zero" during the life of the lining.

Increasing preference is being shown for all-hydraulic foot-brakes as compared with the hydro-mechanical system. The 2½-litre Riley, for example, now has full-hydraulic Girling brakes, with hand-brake operation on the rear wheels by the usual Girling roller expander operated, in this instance, through Bowden cable. Lea-Francis has also made the same change.

An interesting exception to this trend is to be found on the Austin Seven, the Lockheed rear brakes of which are at all times operated mechanically by bell-cranks carried in sliding boxes on the backplates for shoe equalization, both cranks being cross-connected to the usual swivel-tree on the back axle. The rod going back to this is, however, pulled by way of a stirrup by a small hydraulic cylinder carried by the chassis structure. Though final operation of the rear brakes is by mechanical means, equalization between front and rear wheels is taken care of by the hydraulic system.

The hand-brake is arranged conveniently to the right of the driver's seat and close to the floor. This becomes practical on a relatively narrow body owing to the fact that the front windows have not the usual winder mechanism and the bottom of the front door can be recessed to give ample clearance for the knuckles of the driver's hand.

There are still examples of the regrettable 180 deg loop of cable used on some pistol-grip hand-brake mechanisms. Credit should be given to firms such as Austin on their larger models, Alvis and others, who connect the brake grip to the longitudinal rod-work by an upstanding double-armed lever which cuts out the loss of about 30 per cent of the driver's effort involved in the cable system.

Similar commendation should be given to the designers of the new Humber Super Snipe who, being unable to incorporate the simple upstanding lever on account of clearance considerations, have done the next best thing by using upper and lower bell-cranks joined by an inclined rod.

It will be remembered that Ford introduced pendant pedals on the Consul and Zephyr models. A similar layout, but without the hydraulic clutch operation of Ford, is now employed on the new Wolseley Four-Fortyfour car. One of the advantages of this system, the absence of pedal slots difficult to seal, is secured also on the M.G. vehicles. In these, both pedal shanks project vertically through the floor and are sealed by rubber bellows which undergo only slight angular movement.

A few Continental makers continue to fit hand-brakes working on the transmission, in the form of external-contracting brakes at the back of the gearbox or on the axle nose. The axle

multiplication makes this brake vastly easier to apply and hold for a restart on a steep hill. Were the hand brake replaced by a small disc brake, the liability to "shudder," to which the band is somewhat prone, would be removed. Stresses on the crown wheel and pinion during a bungled restart would actually be reduced by this arrangement, which removes the abnormal loads imposed on the rear axle if the clutch is let in before the hand-brake is released. It may be mentioned that transmission hand-brakes are standard equipment of several American delivery vans, in which the number of starts from rest during a day's work is very many times the number made by the average motorist.

Two-leading shoe brakes are completely standard on the front wheels of British cars, with the single exception of the heavier models of the Jaguar car, on which a two-trailing shoe Girling Hydrastatic brake is operated by a Clayton Dewandre vacuum servo. This is done in the interests of smooth operation, free from "grab" under sudden application. Another advantage is that, having a negative servo in the shoes, the braking is not subject to temperature-coefficient fade. It would, of course, be more subject to drum-expansion fade than a normal brake were it not for the follow-up given by the vacuum servo.

Working on Dunlop patents, Girling is developing a disc brake which has already given good results on some racing vehicles. Lockheed is working on a disc brake having many small but important differences from the Dunlop system.

Before discussing constructional details a general idea of the results obtained can be given. In the first place, the fact that in both systems the discs are exposed to water and mud has not been found to increase lining wear as might have been expected. Disc materials are still the subject of experiment; cast-iron, malleable iron and chromium-plated cast-iron are all being tried.

The unexpectedly favourable wear figures are probably due to a combination of circumstances. In the first place, the fully exposed disc, which normally has more friction surface than a standard internal-expanding brake, obviously gets rid of its heat more quickly. Secondly, the fact that the thick disc is caliper-gripped by exactly opposed and uniform forces implies a total absence of distortion due to lining pressure. The internal-expanding brake, even when well ribbed, goes oval under load to an extent varying with the braking force applied. It also increases in diameter with heat. As a result the effective bearing taken by the lining on the drum is continually varying, causing concentrations of load, sometimes at the shoe-tips and sometimes nearer the centre of the shoe. Moreover, the self-servo action of the usual leading shoe can cause great concentration of load on the heel of the lining, whereas in the disc brake lining pressures are at all times uniform.

Expressed in cubic inches of lining wear per mile the disc brake, especially when very dense lining are used, uses up less material than a normal shoe brake. If in some layouts the available area is much less than the normal, this is largely offset by the fact that it is easy and convenient to fit linings of much greater thickness than usual.

In any assessment of the effect of exposure on wear, it must be remembered that the normal brake largely runs in its own abraded drum and lining dust, and that most of the mud and water which may strike the disc are immediately flung off by centrifugal force. The same applies to any abraded dust; anything scraped off by the edges of the lining falls away and is not retained, as in a drum.

Other advantages of the system are that loss of pedal travel due to temperature expansion does not occur, if anything it is negative, and that having an entirely neutral grip, free from self-servo, "shudder" is most unlikely.

To conclude the summary of points common to both Girling and Lockheed systems, it should be observed that the accepted practice is to mount the friction pads in the horizontal plane containing axis, so that with the small running clearances essential to the system they are less likely to be under continual slight movement, as the wheel rocks laterally on the play in the hub bearings or as the axle-shafts deflect when cornering.

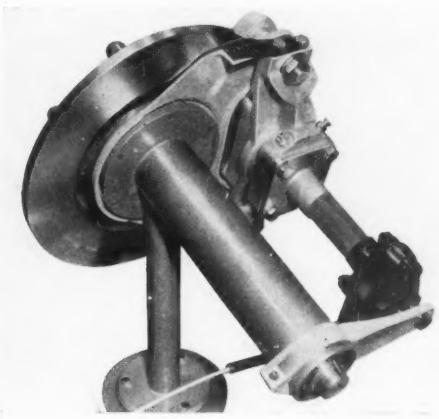
From this point, essential differences begin to appear. To deal with the Girling first, an aluminium-alloy casting, of box section to resist the considerable spreading forces, straddles the disc and is rigidly attached to an equivalent of the brake back-plate.

Three cylinders, with blind outer ends, are through-bored in the casting, the inner ends being sealed by screw plugs and rubber rings. Very short pistons, grooved to take a seal ring, are fitted in opposition, each one having spigoted to it a cylindrical pad of special high-density brake-lining material. As the pads grip the disc on each side, the lateral forces set up by the friction are largely taken by the lining material bearing on the bore of the cylinder. Were they taken entirely by the piston there would be appreciably unequal wear of the lining due to load-transference set up by the drag component; this would be highly undesirable since it would throw the pistons out of line.

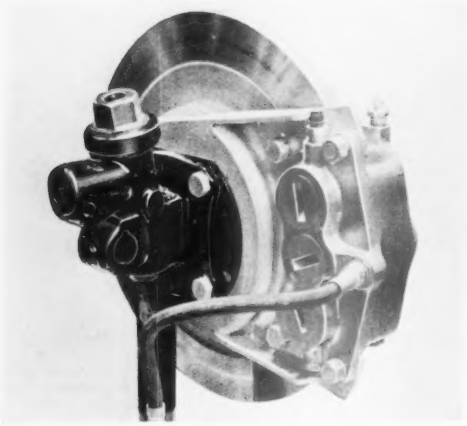
There are, in effect, six separate cylinders, connected by internal drillings and having the usual bleed valves at the top of each group. For a normal size of brake the cylinder and pads are about $1\frac{1}{8}$ in diameter; available pad thickness for wear is about $\frac{1}{8}$ in.

This brake is essentially intended to work on the Hydrastatic principle. There are thus no return springs and the pads bear very lightly on the discs

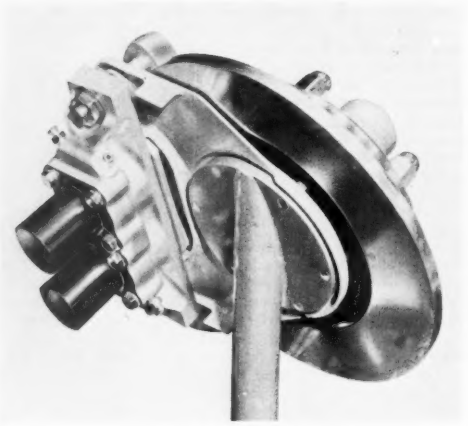
Brake cooling scoop on Frazer-Nash



Lockheed rear disc brake with handbrake operation



Girling disc brake



Lockheed hydraulic disc brake

at all times under the slight residual pressure maintained in the hydraulic system. No adjustment for wear is required, the oil following up the movement of the pistons. At the end of the life of the lining, therefore, the clearance space in the six cylinders for $\frac{1}{8}$ in wear and 1·5 in^2 piston area, has increased by $3\frac{1}{8}$ in^3, or $6\frac{1}{4}$ in^3 for a pair of front brakes.

It is interesting to compare the volume of lining wear available with that of a normal brake. An 11 in diameter by $2\frac{1}{4}$ in 2 L.S. brake has a lining area of about 47·5 in^2 per wheel, or 95 in^2 for the pair. Assuming that $\frac{1}{8}$ in of lining can safely be worn away that is $11\frac{7}{8}$ in^3, or nearly double the amount available on the disc brake.

The theoretical piston travel to wear $\frac{1}{8}$ in of lining off a shoe is about $\frac{1}{4}$ in, but if this is taken as $\frac{3}{8}$ in to be on the safe side, the total increase of clearance in four standard $1\frac{1}{2}$ in diameter cylinders would be $1\frac{1}{2}$ in^3 assuming, of course, snail-cam shoe clearance adjustment. As a matter of fact, many brakes have adjustment between piston and shoe-tip, which eliminates cylinder clearance volume increase altogether, assuming the brakes are kept well adjusted.

It would appear, therefore, that this particular type of disc brake, with the lining pads of the same diameter as the cylinders, gives four times the increase of clearance volume of a normal snail-cam brake, and this on the possibly favourable assumption that the volume wear of the lining is half that of a normal brake.

Admittedly postulating a high standard, it may be queried whether the increased clearance volume will not be thought to lead to undesirable "sponginess" of the brake as the linings wear down. For the present, the Girling brake is only intended for front-wheel use, unless the chassis can be fitted with a transmission brake. In the form exhibited, the disc brake is not suitable for mechanical application.

The Lockheed disc brake has many points of difference from the Girling. In the first place only one set of cylinders is fitted, the outboard facing being riveted direct to the caliper casting. As a consequence, the whole assembly is permitted to float laterally to equalize the load. This movement takes place on two steady pins bridging lugs on the caliper, and serving to tie the two portions together at the ends and giving a notable increase in stiffness.

The inner facing is riveted to a pressure plate having machined lugs at its end sliding laterally in recesses broached in the back-plate equivalent, which also has two reamed holes to take the steady pins. A pair of hydraulic cylinders is bolted to the inner face of the caliper casting. Their pistons operate the pressure plate by two thrust pins, but are not integral with it.

Return springs are fitted and an automatic adjustment is incorporated with each piston to keep the running clearance as small as possible. Details of this automatic adjustment are not yet quite finalized. If pedal travel is to be kept down it is clear that the adjustment must work to fine limits, since the effective piston area is at least three times that of a normal 2 L.S. brake.

The brake lining is of segmental form and has much more area than the circular pads of the Girling arrangement; we understand that the area is only about 30 per cent less than that of the equivalent drum brake. Thickness available for wear is about $\frac{1}{4}$ in and the volume of lining wear permissible is more than that of a drum brake. The usual bleeding provisions are made, and there is also a small spring-loaded pad bearing on a lug on the back-plate to stop rattling of the whole assembly on its steady-pins.

Success of the whole arrangement stands or falls by the automatic adjustment, which is receiving special attention. It works with one great advantage compared with other similar devices on normal brakes. It does not have to cope with thermal expansion of the parts. Therefore, there is no danger that clearance will be set on a hot brake and binding will occur when the parts cool down.

A rear wheel brake with provision for hand brake operation is also shown. Construction is similar, but only one hydraulic cylinder is fitted, this having an appropriate area of piston to give the desired ratio between front and rear braking.

The hand brake cable operates a lever enclosed in a casing connected to the caliper and supported in a sliding steady bearing carried by the axle arm. Recesses on the inboard face of the lever contain steel balls seating in similar recesses in the casing.

Rotation of the lever causes the balls to roll out of their recesses giving an axial movement which is transmitted by a sleeve carrying a ratchet wheel to a push rod screwed into it and bearing, at its outer end, on the pressure plate. A pawl carried by the lever rotates the screwed sleeve on the return stroke when the clearance in the brake and the movement of the lever is sufficient to allow it to drop into the next tooth.

This mechanism, while keeping the hand-brake in adjustment also takes care of the hydraulic cylinder, the volumetric clearance of which increases as the lining wears. This has a relatively unimportant effect on the "sponginess" of the hydraulic system as a whole since the rear wheel cylinder generally has not more than half the area of the front wheel pistons. This will be clear when it is realized that both front and rear brakes have the same "neutral" efficiency; in an ordinary drum brake the cylinders may have the same area, since the front ones are working 2 L.S. and the rear ones in "floating cam" fashion.

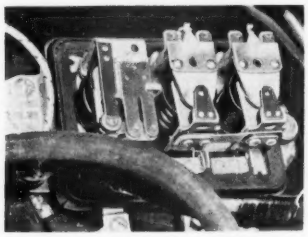
ELECTRICAL EQUIPMENT AND CAR HEATING

Reduction in Range of Units Required. Trend Towards Uniformity in Heating Installations

THE major units of the Lucas electrical equipment on British cars are unchanged from those shown in 1951, and it is evident that requirements are adequately catered for by the small range of models available in these components. That only two sizes of dynamos and three of starters are now sufficient for practically all British cars gives many advantages both as regards manufacturing and subsequent servicing.

Dynamos

The two Lucas dynamos have yoke diameters of 3·9 in and 4·5 in. They are both two pole shunt wound machines with fan ventilation. The maximum output is 19 and 22 amperes respectively at 12 volts nominal. These machines work in conjunction with regulator units mounted together with the cut-out in a control box. The regulator is the compensated voltage control type and has in addition the Lucas temperature compensation spring.



Current voltage control on Kaiser Manhattan

The 12-volt system is now employed on all British cars, with the exception of the Ford Anglia and Prefect, and on most of the Continental models. American and Canadian built cars, however, still use a 6-volt system and in most cases a current control is fitted in addition to the voltage control. The American generators are also two pole shunt wound machines cooled by a fan integral with the driving pulley. They are made with four outputs of 35, 40, 45 and 50 amperes and are either of Autolite or Delco-Remy manufacture. The machines of both makes are evidently interchangeable.

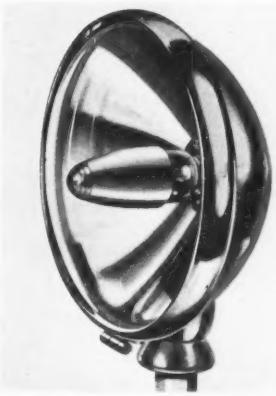
A 45 ampere size appears to be the most generally used, probably because most of the cars shown are large. However, the two Kaiser cars and the Chevrolet had 35 ampere dynamos while the Cadillac had a 45 ampere and the big Chrysler a 50 ampere machine. The Chrysler had Autolite and the others Delco-Remy equipment. Combined current voltage control was fitted in all cases even with the 35 ampere machines, the control boxes having the usual three units. It is interesting to note that the simple form of cut-out is used even with the largest dynamos.

All regulators are temperature controlled and in the Delco-Remy design a bi-metal hinge is fitted to the voltage regulator armature, causing it to operate at a higher voltage when cold and so partly compensating for the increased voltage required to charge the battery. The Autolite system gives similar results but the effect is obtained by a strip of alloy steel in the magnetic circuit, the permeability of the strip being determined by the temperature.

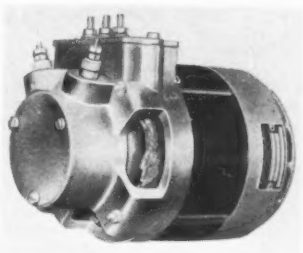
The Scintilla Company showed a range of alternating current dynamos wound for 6, 12 and 24 volts. Outwardly these generators appeared little different from the corresponding direct current examples. They were all three phase machines with three terminals on the stator body, the two rotor terminals being on one end cover and connected to brushes on two slip rings. Current from the three stator terminals is taken to a three phase rectifier and on to a control box of normal design with cut-out and voltage regulator and the usual earth return. The machines are fan cooled in the usual way, the fan being behind the pulley. Very little information was available beyond the fact that all the generators give their full output at 1500 r.p.m. which suggests that they are all four-pole machines.

Starting motors

The three Lucas starting motors fitted to British cars have yoke diameters of 3½ in, 4⅛in and 4½ in. They are used in conjunction with S., S.B. or Eclipse drives. These are all four pole, four brush machines. The two larger sizes have series-parallel field connections, whereas the 3½ in diameter unit has a series field. In nearly all cases the cable from the battery goes to the starter through a relay switch operated from the dash, so that only a minimum length of cable is required and the maximum voltage is applied to the starter. In the smaller American cars such as the Kaiser Manhattan, the starter has a Bendix drive and operates through a relay switch in the usual way. In the Oldsmobile and the other General Motors cars the starter pinion is brought into engagement by a solenoid mounted on the starting motor. The plunger of the solenoid is connected by linkage through a spring to the pinion assembly which is carried on an internally splined tube sliding on the motor mainshaft. The pinion is also coupled to the tube by an overrunning roller free wheel clutch. Closing the starter switch energises the "pull-in" and the "hold-in" windings of the solenoid, causing the plunger to be pulled in and pushing the pinion into engagement with the flywheel gear ring. Completion of the plunger travel closes the main switch contacts, connecting the motor directly to the battery. Closing the main switch contacts cuts out the "pull-in" winding, since this winding is connected across the main contacts. The pull of the "hold-in" winding is sufficient to keep the pinion in gear and cutting out the other winding reduces the drain on the battery. When the engine fires the current falls to a very low value and the control switch opens, disconnecting the hold-in winding so that the shifting lever spring withdraws the plunger and disengages the drive pinion from the flywheel.



Lucas long range driving lamp



Scintilla alternating current generator

On the Hydramatic drive cars a safety switch prevents contact at the

starter unless the selector lever is in the neutral position. The starter motor is a four brush, four pole machine with fan ventilation, and the armature rotates on oilless bushes in the end frames. A switch in the ignition switch assembly controls the starter operating solenoid. This method of operating the starter is the standard Delco-Remy system used in the General Motors cars. It appears to be practically identical with the Autolite method used on other cars, including those in the Chrysler group.

Batteries

The Lucas G.T.W. range of semi-linkless pattern batteries arranged for girdle fixing are now standard equipment on most British cars. They have seven, nine or eleven plates per cell with capacities of 38, 51 and 64 ampere hours respectively. The lead terminal connectors are die-cast on to the battery cable and secured to the battery terminal by a lead-plated self-tapping screw. An acid level indicating device is now fitted to each cell to facilitate topping-up.

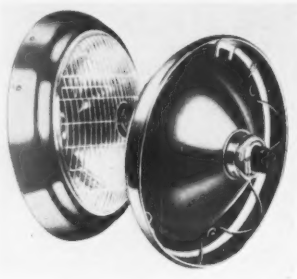
A wide selection of six and twelve volt batteries of standard design were shown by the Chloride Electrical Company, in addition to their Double Life model which is basically as before. In this design the positive plate is enclosed in glass fibre in addition to the usual separators. The Young Accumulator Company had a range of standard batteries in addition to their armoured type in which the positive plate is enclosed in a porous ebonite envelope.

In addition to the normal types the Peto and Radford exhibits included the Dual Life model in which the negative plate is enclosed in a micro-porous plastic envelope in addition to the usual separators. The Oldham Major Battery use their patent Fibrax separators and also enclose the positive plate in glass fibre armouring. It is claimed that this model will remain dry charged for an indefinite period without deterioration. Apparently the enclosing of the positive or negative plates does not appreciably limit the normal starting current. In most instances some device was incorporated or available for indicating the acid level.

Coil ignition equipment

Lucas DM type distributors are fitted to most British cars. They have improved bearings and built-in vacuum control as before. The vacuum advance is effected by partial rotation of the contact breaker plate within the body and is operated through linkage from the vacuum diaphragm. A conventional centrifugal mechanism below the plate advances the cam position relative to the driving shaft so that the body can be fixed unless an additional manual control is required.

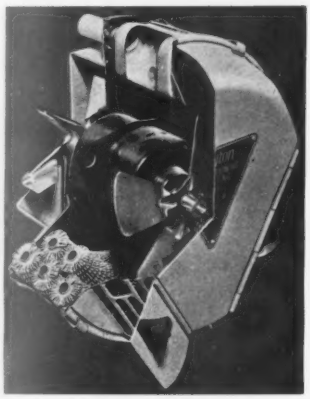
The standard ignition coils are the Q 12 which remains unchanged and a newer pattern, the B 12 designed to operate with wider plug gaps at a correspondingly increased voltage. A new high performance coil, model H.V.12, has been introduced to deal with exceptionally high plug voltages. It is designed primarily for use on sports and racing cars, though it is



Lucas conversion set for old lamps

suitable for all cars where a high performance is required. The coil is capable of functioning at higher speeds than the standard patterns and its increased voltage output makes it possible to use very wide plug gaps. In some engines this gives more even idling and with a suitable carburettor setting improved consumption is obtained under part load conditions.

In the American cars the coil is generally fixed to the engine to decrease secondary transmission losses and also decrease radio interference. In the Delco-Remy type the distributor has combined vacuum and centrifugally operated advance and the shaft rotates in special porous bushes at the top and bottom ends, the upper bush being fed from an oil reservoir in the distributor housing. The breaker plate rests on three bakelite supports which also serve as bearing surfaces against which the plate is held



Clayton Dewandre CB heater

though allowed to rotate to give the vacuum advance.

British Delco-Remy Company has introduced a new oil filled coil which is of interest on account of the very low primary current taken. The model demonstrated was connected to a standard six-cylinder distributor with six sparking plugs and driven by an electric motor. At an equivalent engine speed of about 350 r.p.m. the primary current to the coil was only 1·8 amperes at 12 volts.

In manufacture particular care is taken to remove every trace of moisture, including the oil, from inside the coil, before it is hermetically sealed up, so that subsequent corrosion of the fine wire forming the secondary winding should be prevented.

All the American Ford types and models now use the Loadomatic ignition advance mechanism. The contact breaker plate is operated through linkage from a vacuum diaphragm actuated by the depression at two parts of the carburettor. As no centrifugal mechanism is required, the distributor mainshaft is in one piece and supported by two widely spaced bearings giving great accuracy in synchronizing the firing points of the cylinders.

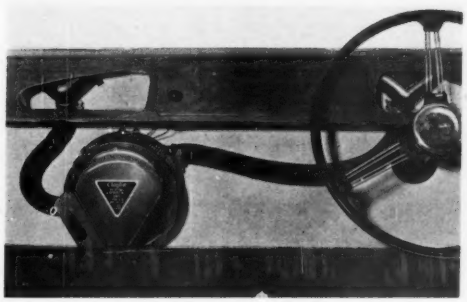
Magnetos

These machines were less in evidence than hitherto. By far the most complete exhibit was that of the Scintilla Company which covered a range from single cylinder to twelve cylinder models. The single and twin cylinder were of the simplest possible design, suitable for small stationary engines. The four and six-cylinder models were of the standard horizontal type and familiar design. The Vertex was shown in six, eight and twelve cylinder form and also as a completely screened unit with provision for screening all leads.

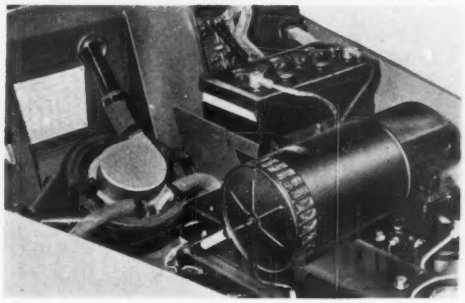
Lucas exhibits demonstrated the satisfactory spark given at slow speeds by their S.R.1 and S.R.4 magnetos. These magnetos are suitable for use with industrial, agricultural and marine petrol engines. The design is simple and the construction is such as to protect the working parts as much as possible from dirt and moisture. They have rotating magnets so that the windings, condenser and contact breaker are stationary.

Wico-Pacey showed their horizontal magneto which can be assembled to give a variety of types according to the components chosen. These components though of different types are made interchangeable and can be so assembled as to produce a wide range of models.

Several sizes of two-stroke flywheel magnetos were shown, the magnets being cast into the flywheel rim so that the coils and contact breakers could be mounted on the stationary back plate. In addition to the magneto coil an additional lighting coil can be fitted when required and used either for lighting or battery charging through a



Clayton Dewandre demister installation



Armstrong Siddeley Whitley heating installation

rectifier or for both together. A range of sparking plugs with ceramic insulators was on view, covering most of 14 mm. and 18 mm. ranges.

Ignition interference suppressors

It has been announced that legislation will be introduced at the next Parliamentary session to deal with this trouble and although several publications have been issued by the British Standards Institution, no specific method has been put forward for general application. The usual method is to insert resistances in the high tension circuit to reduce the oscillatory condition of the discharge. In many cases a single resistance of about 10,000 ohms at the distributor end of the high tension lead is sufficient. In other cases an additional resistance in each plug lead is required and can be in the form of a resistor at the plug terminal or a high resistance lead.

Resistance units for these purposes are shown by several firms, such as Lucas and the Ediswan Company. It is claimed that the values employed do not adversely affect the performance of normal engines. Unfortunately a normal arrangement of the ignition units and leads can easily be such as to cause radiation within the television frequency band, or close enough to cause interference, so that it may be difficult to specify a system of suppression which will be efficient in all cases. It will be unfortunate if screening should be required, because of its complication and the effect on the ignition.

Lighting equipment

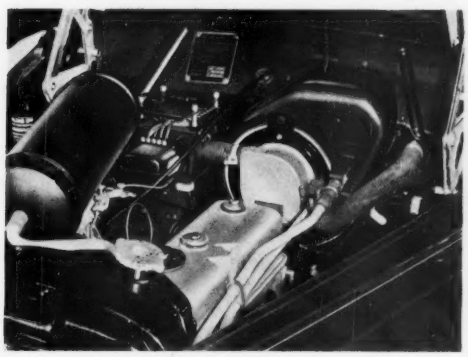
Flush fitting headlamps with the Lucas "light unit" and block pattern front lenses are almost universal. Prefocus bulbs with twin filaments and double dipping are used as before, though it is interesting to note that one car on the Rolls-Royce stand was fitted with headlamps of the old P.100 type. Headlamps on both American and Continental cars follow the same general scheme and are all flush fitting. In the American cars, however, the "sealed beam" unit takes the place of the Lucas light unit.

Joseph Lucas Ltd. showed a conversion set consisting of interchangeable chromium plated rims, complete light units with prefocus bulbs and including adaptors and cables so that the fitting should present no difficulty. They are designed for fitting to the lamps of the majority of pre-war cars.

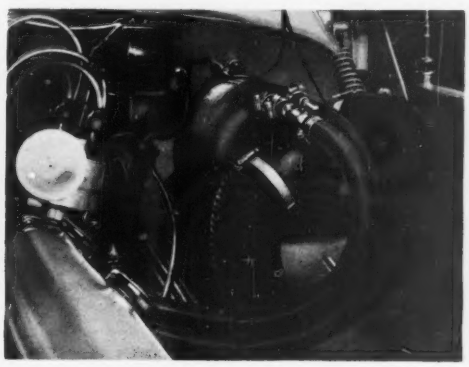
A long-range driving lamp, model SLR 700 S, is now available for the home market. It has a powerful long range beam and is designed for use in conjunction with existing headlamps, giving the extra vision necessary for fast night driving. The lamp has an aluminized reflector with plain front glass and the whole design is such as to concentrate as much as possible of the light into a narrow beam of maximum intensity. On account of the number of accidents that have occurred due to poor rear lighting of vehicles, Lucas have given considerable attention to the need for improved visibility. The new designs of rear lamps are now more efficient owing to the better optical shape of the glass. In addition nearly all cars now have lights on each rear wing to indicate the width of the vehicle. Stop lights are also similarly improved and should be visible in bright sunlight. A very efficient rear reflector has also been introduced. It is a special petrol and oil resisting red thermo-plastic unit and has been introduced for fitting in addition to the standard rear lamps.

Screen wipers

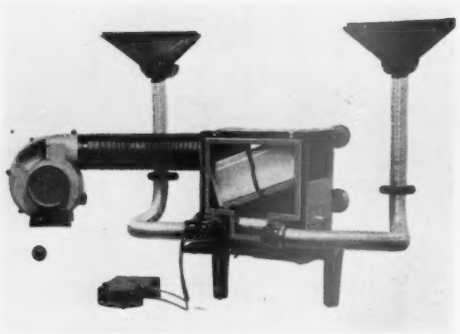
Two patterns of Lucas cable-rack wipers are standard equipment on British cars. The C.R.T. type is fitted to the more popular models. Generally its motor and gearbox are mounted on the bulkhead. A more powerful model, the D.R. type, is fitted to some of the higher-priced cars and is particularly suitable for large curved screens. The



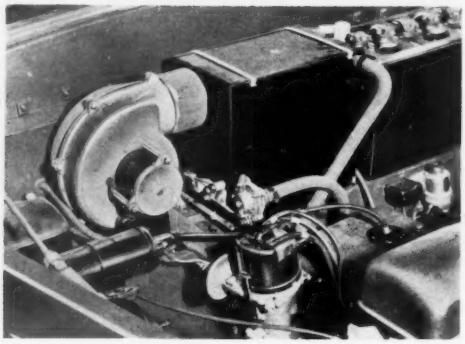
Lanchester heating installation



Delaney Gallay A9 heater on Alfa-Romeo 2-litre



Smith 3½ kW heating and demisting installation



Armstrong Siddeley Sapphire heating installation

motor has two speeds obtained by field control and the blades are automatically returned to the parking position when the motor is switched off.

American cars either have two-speed electric wiper motors, as in the case of the Kaiser, or else a suction motor as on the General Motors cars. On the Cadillac, the oscillating suction motor is mounted under the bonnet and driven by the depression in the inlet manifold, supplemented by a suction pump incorporated in the fuel pump. The motor drives an auxiliary shaft carrying a crank, to which are attached the cables operating the wiper arms. These cables pass over pulleys, which are cable tensioners each having a spring and ratchet to take up slack. The motors are quite inaudible in operation and are said to be sufficiently powerful to deal with any normal screen condition.

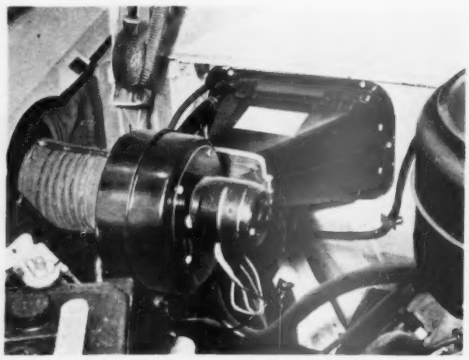
Heating equipment

Much progress is apparent in heating installations. In most of the more expensive cars and many of the medium-priced ones, heating equipment is now a standard fitment. The general scheme of the installations is becoming more uniform, as well as simpler. Most cars draw in fresh air through the heater and take it either from the front grille, as on the Austin and Rover, or through the ventilator in the scuttle, as on Daimler, Lanchester and Hudson.

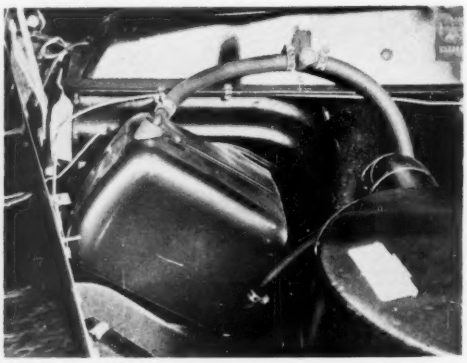
The heater unit is generally attached to the engine bulkhead and delivers heated fresh air through tubes to the demisting slots above. Another outlet at the bottom of the unit directs air downwards to the floor of the front compartment to pass under the front seats to the rear passengers. In the large cars, a second heater unit, frequently of the recirculating type, warms the back part of the body. Ducting of the air after passing through the heater is rarely resorted to except in passenger coaches and similar vehicles.

The smaller complete heater units made by S. Smith and Sons, Clayton Dewandre and Delaney-Gallay include their own fan. In the Clayton C.B. heater, two fans are used, part of the air being directed by one fan at a medium pressure through pipes to the demisting slots, while the other fan delivers air at low pressure to the floor at the driver's feet. Good examples of Clayton C.B. heater installations were to be seen on the Lanchester Fourteen, the 3-litre Daimler, the Triumph Renown and the Armstrong Siddeley Whitley amongst others. The arrangement is basically the same in all cases, the complete unit being attached to the bulkhead and drawing fresh air from outside the body.

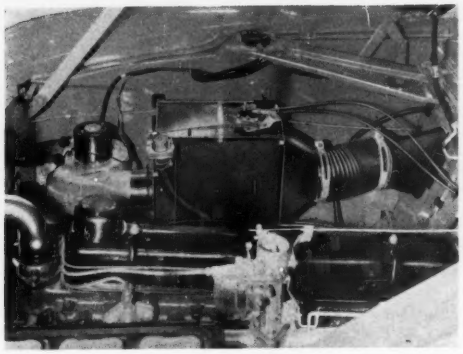
The Clayton C.B. unit is circular in shape, with a heating element comprised of a ring of "Clayton Still" wire wound tubing forming the outer wall and connected to the engine cooling system. A centrifugal volute casing at the rear end accommodates either single or twin demister tubes. A low consumption electric motor built into the centre of the heater has a fan fitted to each end of its shaft. The two fans draw air into the periphery of the unit through the heater coils. The front fan delivers warm air through the central doors of the front cover while the rear fan, running in the volute casing, discharges air to the screen slots. With the standard fresh air intake, output is said to be about 6,000 B.T.U. per hour. The S.C.1 and the R.C.2 units are designed for saloon cars, the former being



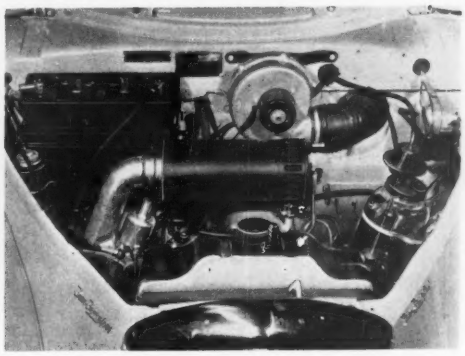
Heater unit and blower on Ford Mercury



Kaiser Manhattan heater unit



Heater unit on Ford Zephyr



Heater unit on Wolseley Four-Fortyfour

similar to the C.B. type. The R.C.2 is a more powerful unit for larger cars. For example, the Humber Imperial limousine uses the R.C. type for heating the rear compartment.

In the S. Smith and Sons installations the 3½ kW heater unit with separate blower is generally used on medium-sized cars such as the Rover, Armstrong Siddeley Sapphire, Austin Hereford and A.40, Ford Consul and Zephyr, four and six-cylinder Morris Oxfords, and the Wolseley Four-Fortyfour amongst others. Many of these have been described previously and are substantially unchanged. The temperature and air distribution are controlled from a small panel that can be mounted in any convenient place such as the lower edge of the facia board within reach of the driver. Fan speed is not controlled, since sufficient variation of temperature is obtainable by adjustment of the air distribution as before. The arrangement most generally preferred has the heater and fan mounted together on the engine side of the bulkhead as in the Armstrong Siddeley Sapphire or Jaguar Mark VII.

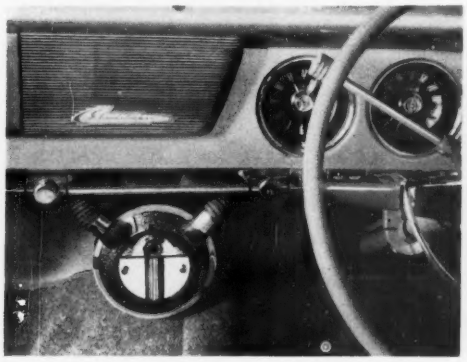
Fresh air is drawn from the front grille through a large flexible pipe to the blower. In some applications, the heater unit only is fixed to the bulkhead.

On the Rolls-Royce and Bentley cars the blower is at the intake end of the air pipe and located at the bottom corner of the main radiator, so that air noises within the body are reduced. In addition to the heated fresh air that is used for demisting and ventilating, the circulating heater supplies additional heat if required, regulation being by a two-speed motor switch. The second heater is not required in the case of average sizes of bodies. On the Armstrong Siddeley Sapphire, for example, sufficient heat for both body heating and screen demisting is available from the standard unit and control system. A similar unit with a rating of 4 kW is made by S. Smith and Sons for fitting to cars of the Rootes Group. The operation and control are the same as in the 3½ kW model.

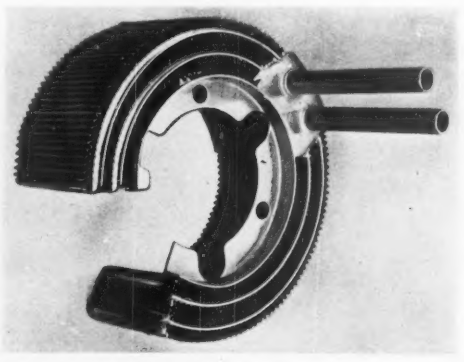
American cars generally have two large diameter ducts extending from the front of the car to the body. One of these delivers air through the heater and is controlled by a thermostat, the other duct serving only as a ventilator.

The small circular combined unit installed on the Fiat 1900 model supplies the demisting slots and delivers air to the body through hinged doors on the front face. These doors can be rotated to direct the body air in the required direction. Delaney-Gallay use the same matrix on the three types of heater that were exhibited. The A.4 type is designed primarily for fitting to existing cars and is supplied with a universal kit of parts suitable for most cars. It is a recirculating and demisting unit with its own fan, and can be used with fresh air intake if required.

The A.9 can be used with a fresh air intake or for recirculating, as preferred, control being effected by a two-way valve operated from within the body. This unit is used in the 2-litre Alpha - Romeo installation which also includes a large cold air pipe at the opposite side of the bonnet. The A.100 type is used chiefly for heating the rear compartment of large bodies. It is strap-mounted and can be fixed in any position as required, and can be used with a fresh air intake or as a recirculating unit.



Delaney Gallay A4 heater unit on Studebaker



Delaney Gallay A9 heater matrix

COACHWORK

Lighter Construction : Increased Luggage Space

IN so far as general outline is concerned there was no outstanding design of bodywork at the Exhibition. In fact those who have followed the trend of design for the past two years would hardly expect any marked modification in the general exterior form of coachwork. There was, however a very definite trend towards lighter construction, coachbuilders having at last realized that many of the essential components hitherto used for retaining other units, could be used to advantage for adding strength to the general structure, with the result that a second component could be eliminated.

Front seats are a case in point, and it was noticeable that H. J. Mulliner Ltd. have taken advantage of the inherent strength available in the seat slides and now use them as an integral part of the front seat construction on the new Continental body. Furthermore, the valance plate necessary to retain the cushion is also used as a means of obtaining strength; by adopting these methods a worth while saving in weight has been made.

The saving of body weight has been very much in the minds of designers, and there is evidence that light alloy body frame construction can be employed without affecting external shape. It has of course, been apparent for many years that a built-up all-metal construction as distinct from the fully tooled pressed panel method can give an external appearance similar to that of the traditional coachbuilt method. Park Ward for example, have for the last 15 years employed an all-steel method of construction, and it is indeed difficult for an average car purchaser to detect that the well swept saloon or coupé shown by Park Ward has a metal framed body.

Several coachbuilders, and some car manufacturers have adopted an unorthodox method to give improved luggage accommodation. For example, two car manufacturers employ an unconventional location for the petrol tank to allow all, or practically all, of the space within the boot panels to be used for the housing of the spare wheel, and for luggage. One example is in a Daimler coupé which has petrol tanks located in the rear wings, where they encroach slightly on the luggage accommodation, and the second is an A.C. coupé which has a six-gallon petrol tank housed in the rear end of each front wing. It may be recalled that two years ago Jaguar Cars Ltd. fitted tanks in the rear wings of their Mark VII.

Another means of improving luggage accommodation consists of folding the rear seat squab board forward to a horizontal position. In one case this allows luggage within the boot to extend forwards into the seating compartment. In a second design where greater precaution is taken to exclude engine fumes, a fixed squab board is retained, but the seat squabs can also be folded to a horizontal position so that a considerable quantity of luggage can be stored behind the driving seat.

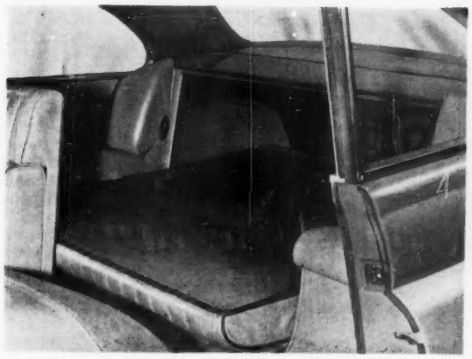
In general, the bodies shown by coachbuilders were notable for good lines, and in contradistinction to some of the previous Exhibitions, it was impossible to pick out any one body which offended the idea. There were of course the few ostentatious examples embodying ideas that few will commend. One interesting point in connection with standardized coachwork is the introduction for the first time by one manufacturer, of a model using the unitary method of construction, eliminating a separate chassis frame. This was to be seen in the new Wolseley in which the body, produced by the Pressed Steel Company, has been the subject of considerable thought.

Amongst the builders of convertible coachwork. E. D. Abbott Ltd. have for some years taken a prominent place, and their exhibits included a Bentley drop-head body with a power-operated head. There is accommodation for four or five passengers and the two doors are hung on the front pillars by a special design of hinge which this coachbuilder has developed, and which allows the door to be adjusted vertically when alignment is required. Another feature of this body which has been used on Abbott convertible bodies for some time is the device for contracting the centre pillar as the roof is folded. This contraction, which occurs at waist height, permits the pillar tops to pass inside the elbows.

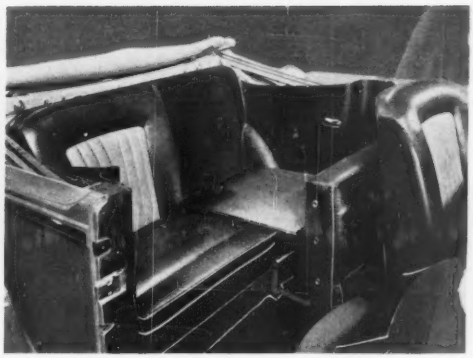
A saloon body exhibited by this coachbuilder was a two-door sports saloon on a Bentley chassis, and in the design of this body special attention has been devoted to the reduction of wind resistance. The car is of minimum overall height, and by close coupling the seats, a long swept tail is possible, the front wings being carried through high on the doors to meet the rear wings. Arrangements are made in this body for the accommodation of a maximum amount of luggage. This is made possible by the elimination of the fixed squab board for dividing the seat compartment from the boot. Thus, by folding the rear squab which remains in a horizontal position and is then level with the adjacent boot floor, it is possible to stow lengthy articles in the combined boot and rear compartment. However, exceptional care will have to be taken to ensure that exhaust and petrol fumes which are very difficult to exclude from the boot, do not find their way into the seating compartment.

The body is of composite construction, metal reinforcement being used wherever necessary. As a means of securing a stiff underframe, the body

Sweeping lines characterize this Hooper-bodied Daimler



To improve luggage accommodation on the Abbott-bodied Bentley, the rear squab hinges forward



Divided and hinged rear cushions giving luggage accommodation on Park Ward coupé on Rolls-Royce Silver Dawn chassis

sills are composed of metal to form box section member having dimensions of 6 in × 4 in. The floor also is composed of metal, the body being aluminium panelled. The width over the screen pillars is slightly greater than usual, which also increases the overall dimension at the front seats. This is done by increasing the effective width of the standard Bentley dash.

Prominent amongst new standardized bodies is the Armstrong Siddeley Sapphire. This interesting chassis carries four-door, four-light and six-light bodies that do not perhaps arouse the same technical interest as the chassis. It is for example, unusual in these days to find a new design with rather obvious external door hinges, and although the line of the front wing as it passes across the doors is exceptionally good and pleasing, the boot line has not the same distinction. The front wings meet the rear wings near the base and gradually taper in plan to leave a fully exposed rear, wing the line of the front wings being carried over the rear wing spats by a swaged section.

Another unusual feature in this production body is the use of squared corners to the window frames. This is in keeping with the general form of the roof structure, and gives noticeable distinction. Both doors are hung on the mid-pillars and thus the front door opening at the forward edge is contrary to general practice.

In the construction of the body the shell is built up from a series of fabricated panels composed of a number of small pressings produced from 19 gauge steel. These panels are united by welding in an assembly jig that involves careful hand fitting, a method that has the advantage of eliminating heavy tool charges.

An interesting point concerns the base of the seats which consists of a Snake wire foundation instead of the more usual coil or tension spring. The Snake wire is covered with a latex foam overlay before the final trimming. This arrangement is used for the front seats only, the rear seats having coil spring foundations.

The new Daimler 3-litre chassis was shown with an attractive convertible coupé body by Barker. This is a two-door body and is noteworthy for its clean lines, which are enhanced by the long sloping wings carried across the doors to turn with a quick radius into the line of the rear wings. There is a downswept bonnet moulding passing across the rear wing to turn into the bottom line of the body, so that a distinct break is made between the two contrasting colours in which the car is finished.

Reference has already been made to the rear wing location of the petrol tanks on this Daimler. They occupy the rearward portions of the wings, where they encroach to only a slight extent upon the space within the boot. To improve the luggage capacity still further, the manufacturers have developed an interesting spare wheel arrangement. It consists of a cradle mounted on parallel links of unequal length beneath the floor. The whole cradle is controlled by worm and nut mechanism that is operated from above the body floor. Rotation of a hexagon head by the wheel brace lowers the spare wheel. The unequal length of the supporting links is such that as the cradle is lowered the rearward end passes beneath the rear bumper, enabling the spare wheel to be removed with little trouble. No special device is needed to secure the wheel on the cradle, for when fully raised the wheel bears against rubber blocks attached to the underside of the floor so that rattle and movement are impossible.

In the construction of this Barker body, the bottom frame arrangement is interesting, for the sills consist of two large diameter steel tubes supported from the chassis by brackets shaped to receive them. Brackets to carry the pillars are welded to the sill tubes, and this bottom frame is still further strengthened by the firm attachment of the rear wheel arch panels. The rear seat heel board consists of a steel plate securely connected to the sill tubes, and at the scuttle, a transverse tube serves the purpose of strengthening the bottom frame.

The convertible body is a type which requires a strong bottom frame if scuttle and front pillar shake are to be avoided and this latest Barker method should be of considerable assistance in overcoming the trouble. A power-operated head is used and this system of operation is also extended to the main door windows, pivoted quarter lights and boot lid, which last is automatically operated when the securing handle is released. A flap in the rear wing gives access to the petrol filler, a control within the boot being the only means of operating the lid. There is a curved windscreen which has thin pillars, and the screen top rail is slightly curved to harmonize with the transverse contour of the roof. The

A long luggage boot characterizes this E.D. Abbott Bentley

This Armstrong Siddeley Sapphire saloon is also available in four-light form

front seat is divided, each half being separately adjustable, and to give access to the rear seats, the front squabs may be hinged forwards.

A slight improvement in the arrangement for accommodating luggage has been made on the standard Bentley saloon. The body shell is a product of the Pressed Steel Company, but trimming and finishing are carried out at the chassis manufacturer's own works. Basically the body is the same as the Bentley Mark VI saloon previously manufactured, but certain alterations have been made to the rear end to give greater luggage accommodation. There is a longer boot than hitherto and it has been found necessary to extend the frame side members to provide body mountings further to the rear, but this is not all that has been done to improve accommodation.

The petrol tank has been redesigned to enable the spare wheel, which is horizontally mounted, to be carried closer to the frame, and although the floor above the spare wheel is still high, it is turned down at each side of the wheel to enable luggage to be placed in wells against the wheel arches at a lower level. The central spare wheel housing accommodates wheel changing equipment. A departure from previous practice is that the luggage lid is hinged on its top edge and cannot therefore be used as a luggage platform. A torsion bar arrangement is used to counterbalance the lid, and a mercury switch in the locker lid controls an interior light. As on previous cars of this make the trimming in the Bentley saloon embodies comfortable head rests at the sides of the rear seat. A further point of interest is that the rear window is prevented from misting by the use of heating wires of 0·008 in diameter, which are spaced to cover an area of 24 in × 8 in, these wires being arranged between the laminations of the Triplex safety glass.

There are several interesting technical features in the design of the new Wolseley Four-Fortyfour saloon, which has a body shell produced by the Pressed Steel Company. This is a four-door four-light saloon. It has front wings which pass across the doors at waist height and gradually merge into the side panels until at the junction with the rear wing there is no appreciable break in line. This car is of unitary construction and considerable thought has been given to the formation of the floor and under-body structure to obtain a sound foundation in place of the conventional chassis frame.

To carry the engine, two tubes project forwards from the under-body. They are connected by a cross member that extends on either side to form housings for the front suspension units. The front wing inner valances and all panel work forward of the dash are not connected to the tubes but are cantilevered from the bulkhead to pick up a central mounting at the front. Thus, an attempt has been made to relieve the wings and bonnet from distortion arising from the front wheel movement, and there should be a freedom from front end rattles and fractures.

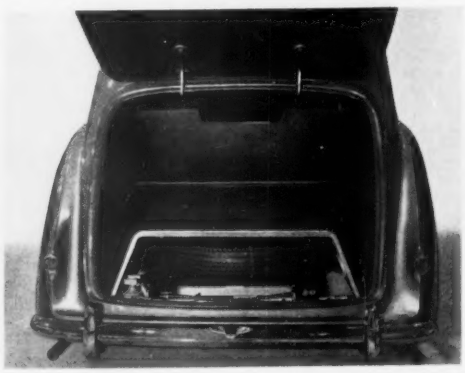
Concerning the body under-frame itself, there is a tube at either side that replaces the normal body sill, and these sill tubes are supplemented by a very substantial central tunnel extending from the front bulkhead to the rear seat heel board. The rear seat pan itself continues the line of the central tunnel to meet the rear squab board. There is a substantial cross member connecting the tunnel and sill tubes beneath the front seats, and the floor itself is liberally swaged to add still further to the strength of the under-frame. The petrol tank is located on a shelf behind the rear seat squab, and the petrol tank filler is behind a lid arranged in the quarter panel. This lid embodies the petrol filler cap itself, and is opened by a control mechanism inside the boot.

Front and rear doors are hung on the forward pillars on concealed hinges. In common with a number of standard productions, the rear doors are shaped to fit over the forward portions of the rear wings to prevent passengers entering the rear seats, from being soiled by contact with a dirty wing. The boot lid is hinged at the top and is mounted on concealed hinges, a hairpin torsion bar device being used to counterbalance the lid. Each of the doors is provided with check mechanism to prevent the doors from closing when the car is on a camber. Schonitzer press-button locks are fitted.

Another new model was the Humber Super Snipe, which is comprehensively equipped, its fittings including press-button door locks, spring-assisted bonnet and luggage boot lids. Its spare wheel is carried in a spacious rear locker and can be removed without disturbing the luggage.

Although the H. J. Mulliner-bodied Continental Bentley was announced some months ago, its first public

Petrol tanks in rear wings and spare wheel arrangement on Daimler 3-litre chassis



Luggage and spare wheel accommodation on standard Bentley saloon

TYPICAL STYLING FOR QUANTITY PRODUCTION

Ford Consul

Wolseley Four-Fortyfour

Vauxhall Wyvern

Austin A30

Horizontal lines predominate in the new Humber Super Snipe saloon

appearance in this country was at the Exhibition, where examples were to be seen on the chassis manufacturer's stand, and also amongst the coachbuilders' display. This is a most interesting body, for its construction is a natural development of the lightweight all-metal Bentley saloon which H. J. Mulliner exhibited for the first time two years ago. It will be realized that this coachbuilder has eliminated timber as a structural material and for these special bodies is using aluminium alloy, with the result that the complete weight of the new Bentley Continental saloon is 33½ cwt. This low weight has a very great bearing on the performance of this car, which is capable of a maximum speed in the region of 120 m.p.h. The comparative weight figure for the standard steel Bentley saloon is 38½ cwt.

The Continental saloon is a two-door body with well swept wing and roof lines that are the result of extensive tunnel tests, and it is interesting to note that two features having considerable influence on the appearance of this car have been developed through this scientific investigation. For example, the curved screen does not follow the usual regular transverse contour but has a varying radius to give the roof mass a better entry into the air stream. The second point concerns the rear wings, which at the back end are of considerable depth and might be termed ugly, but these deep wings in conjunction with the downswept roof panels create fins that have a stabilizing effect on the car. This is, doubtless, the reason for the similar treatment that is frequently found on streamlined American cars. For the same aerodynamic reasons, the front wings, which are continued along the body side panels, maintain their height with a gentle curve until they pass behind the screen pillars, from which point they are slightly downswept to meet the rear wings at a short distance below the waist rail. The rear wings are fitted with detachable spats.

This is a close-coupled four-seater body, and although every effort has been made to reduce weight, reduction has not been at the expense of body equipment. It is, however, noted that such items as the back light blind, which when electrically operated adds a few pounds to the weight, has been eliminated, its place being taken by the two-position driving mirror. Incidentally, the back light is fitted with demisting equipment, not of the standard Bentley pattern using resistance wires, but comprising a feed taken from the main screen demisting installation and feeds cold or warm air to the back light as desired.

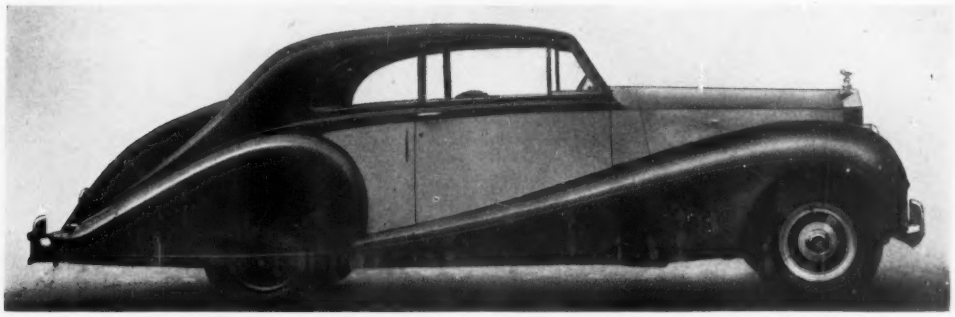
Special attention has been given to the design of seats, which at the front are of pronounced bucket form, securely locating the occupants when the car is being driven at speed and may have to swerve. Similarly, the squabs of the rear seat are slightly bucketed. Although the car is low, there is ample head room for the rear seat passengers, who are provided with a central folding arm rest and two side arm rests. Due to the shape of the roof panel which continues rearwards to form the upper panel of the boot, there is ample luggage space at the back. To give additional room, the spare wheel, which is on the boot floor, is mounted on the near side and is recessed into the near side rear wing. The boot lid is hinged at the top and is counterbalanced by a spring device.

Despite the pronounced slope of the rear roof panel, there is adequate rear vision from the driving seat. Visibility generally in this car is greatly improved by the narrow upper pillars which are of light alloy metal sections. Another interesting point is that the bumpers are fabricated from light alloy, with a consequent considerable saving in weight.

Some of the attention devoted to aerodynamics on this Continental Bentley is not readily apparent. For example, the front wings and front apron are so shaped that air which strikes them is deflected beneath the car instead of flowing on to the upper panels. Similarly, the prevent the air stream that passes under the car from entering a pocket such as that created by the rear bumper, an undershield extends rearwards from the front lower edge of the petrol tank to meet the underside of the bumper and pass the aid stream clear of the car.

Light weight Bentley Continental with H. J. Mulliner coachwork

Low front wing and apron line is evident on the Bentley Continental



Attractive Freestone and Webb two-door saloon on Rolls-Royce Silver Wraith

A touring limousine on a Rolls-Royce Silver Wraith was also shown by H. J. Mulliner. This body had four doors on concealed hinges, with both front and rear doors closing on the centre pillar. Push-button door locks of the coachbuilder's own design are used. Seating accommodation is provided for five persons, and the division glass at the back of the driver can be dropped by means of electrically-operated mechanism. The back of the division incorporates polished wood folding tables. In the front compartment the seats are separate, adjustment being provided for the driver's seat. The door window mechanisms are manually operated and swivelling ventilating panels are used in the front door windows, and also in the quarters, the entire window in this case being hinged. The luggage boot at the rear is fitted with a door hinged at the top and gives exceptionally commodious accommodation for a car of this type.

For the four-door six-light saloon which H. J. Mulliner exhibited on a Bentley chassis, all-metal light alloy construction is used. The design of this body is virtually unaltered from the form in which it was exhibited for the first time two years ago. Both front and rear doors close on the central pillars and the hinging edge of the rear door contains a shaped portion to continue the very deep wing line. There is the usual heating and demisting equipment and the luggage boot has a lid which is hinged at the top, a spring balance device being used. The four-door six-light saloon which this coachbuilder exhibited on a Bentley follows orthodox construction and is panelled in aluminium.

A striking design of two-door fixed head coupé was shown by Hooper on a straight-eight Daimler chassis, and attracted attention for a number of reasons. It has very pronounced sweeping lines which the length of the body shows to the best advantage, and its low overall height gives the impression that the car is even longer than is actually the case. The body is finished in two tones of metallic blue, the darker tone being used above the waist moulding and also for the long swept front wings. These are continued rearwards to work into the general decorative scheme of the side moulding and boot in such a way that the rear wings are not visible. The light metallic blue finish for the sides of the bonnet and body carry a "quatrefoil" motif, although being on a light ground, this is not unduly obvious. Among the special features used on this striking body is a glass panel in the front portion of the fixed roof; a sliding shutter is provided to cover this roof panel when protection is desired. The door windows are composed of double glasses which have an air space between them to prevent misting. This is a very practical feature. The double glasses are united to form one window panel, and the extra glass thickness is accommodated in special glass runs, the upper portion of the door pillars being slightly but not unduly increased in size. To prevent the heat of the sun from causing discomfort to the passengers, the roof is insulated between the inner and outer panels by a proprietary glass wool material that fills the one-inch depth between the two panels. To feed the heater unit there is an inlet arranged on top of the scuttle.

Of the several bodies shown by Freestone and Webb, an outstanding example was the two-door four-light saloon shown on a Rolls-Royce Silver Wraith chassis. The lines of this body are particularly good, a long sloping front wing passing across the door and quarter panel to meet the rear wing at its base. The portion that crosses the door opens with the door, which is hinged on its forward edge, and access to both front and rear seats is noticeably easy, the front seat folding forward to facilitate entry to the rear. A point in connection with the folding backs of the front seats is that they can be adjusted over a range of $2\frac{1}{2}$ in. The near side half of the rear seat heel board accommodates a drawer which, on being withdrawn, reveals a Dictaphone. This is an unusual fitting and could be of great value to business executives.

The interior of the car is extremely well carried out, the finishers being in olive ash veneer with a semi-matt finish. Two paper racks are built into the rear of the front seat squabs, and illuminated smokers' companions are embodied in the quarter finishers. Below the centre of the instrument board, the usual press-button radio set is installed. An extension speaker is mounted on the rear parcel shelf beneath the back light. The window frames consist of light metal sections and ventilating panels are arranged at the forward end of the door windows. The quarter lights are also arranged to open, and the back light is thermally heated.

The James Young Bentley saloon has excellent lines

Concealed lock-operating mechanism on Park Ward wing spat

Division arrangement used on Park Ward Rolls-Royce limousine

Another well equipped body by Freestone and Webb was a Rolls-Royce limousine with all the interior woodwork carried out in walnut having a plain gloss finish. The division embodies two folding tables provided with self-positioning mirrors, and a central mirror-backed cabinet houses cocktail requisites and a ladies' portable travelling set.

The four-door sport saloon shown by James Young Ltd. on a Bentley chassis has a forward-mounted radiator which is an arrangement this coachbuilder adopts to suit the special design of front wing. Other special features introduced by James Young Ltd to suit special equipment concerns modified air inlet grilles, which differ from the normal circular pattern used by the chassis manufacturer. They are of horizontal form, and it is claimed that they improve the flow of air to the heating system. These horizontal air inlets are arranged below the head lamps and are rather less obtrusive than the standard pattern with vertical bars. Another modification which this coachbuilder makes to standard equipment is the addition of extra metal to the upper face of both front and rear bumpers. On the examples exhibited, it was not possible to detect any distortion where the extra metal had been added.

In the four-door sports saloon there is seating accommodation for five persons, three of whom are carried on the rear seat. The front seat is of bench type with two centre arm rests; the seat is divided, and each section is adjustable. A spacious luggage locker at the rear has a spring-assisted lid hinged on its top edge, the spar wheel being mounted in its usual position on the boot floor. The two-door Bentley saloon shown by this coachbuilder follows similar lines, having its door hinged on the forward pillar and being equipped with press-button locks. There is a hand-operated back-light blind and the doors are provided with useful lockers.

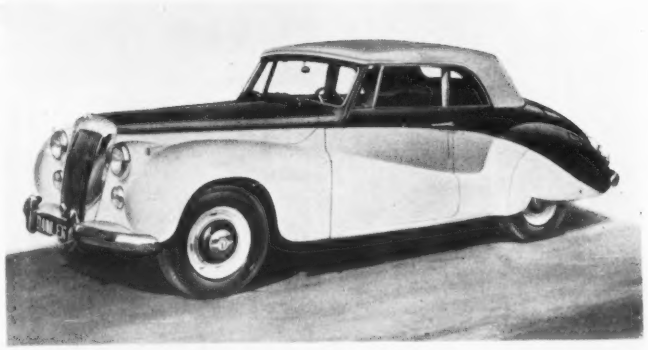
Some very interesting bodies were shown by Park Ward, who have developed a drop-head coupé with an exceptionally light head operation. In addition to the particular care that has obviously been given to the design and construction of the roof mechanism, the coachbuilders have succeeded in providing much greater luggage accommodation. There is the usual luggage boot which also accommodates the spare wheel, but to supplement the storage space in the boot and still keep luggage under cover it is possible, when only two persons are travelling, to hinge the rear seat cushion forwards, hinge flaps centred at floor level passing in front of the heel board to turn along the base of the seat board. Thus, when the cushion is hinged forwards, it stand upright behind the front seat back, and it is then possible to hinge the squab causing it to lie horizontally on the rear seat pan. The back of this squab board is adequately protected by rubber sheeting, and the fixed squab board, which is retained to exclude fumes and dust, is also protected by carpet. To allow the car to carry its full complement of luggage with three passengers, the rear cushion and squab are divided, making it possible for one half of the entire seat width to be hinged, while the other half gives normal seating accommodation.

Rolls-Royce saloon with coachwork by Rippon

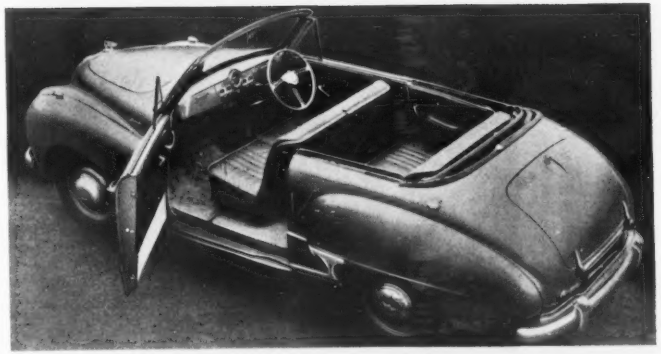
The interior of this drop-head coupé is particularly well finished, the cappings consisting of grey sycamore veneer with cross banding in pewter. Cocktail cabinets are recessed into the doors and are fitted with pewter flasks. The body framework is constructed of steel, a method which Park Ward have used for some years, but in the interest of weight reduction, light alloy framing is used for the doors and boot lid. As this is a convertible body, special attention has been given to the scuttle construction, which has a steel inner skin and external panel work in aluminium alloy. Another interesting point is the use of a large transparent p.v.c. back

Austin Healey 100

Triumph Roadster



Daimler Convertible



Austin A40 Convertible

Lagonda with Graber body

light with a thickness of 0·040 in.

Park Ward have developed a novel arrangement for opening the rear wing spat, which is carried on parallel arms hinged to the body and also to the spat. These arms are accommodated in the wing recess when closed. The feature of the arrangement is that there is no visible means of operating the spat locks, which are at each lower corner and also at the top, but the handle which withdraws the bolts is situated inside the spat at the top of the centre cut-out, where it is quite simple to operate.

Another Park Ward exhibit notable for its excellent interior finish was a Rolls-Royce Silver Wraith limousine in which special care has been devoted to the layout of the division. The most noticeable feature of this division concerns the use of a curved glass which unlike earlier fittings made to lower the glass at an angle, is supported by its side runs for the whole course of its travel, this operation being electrically controlled. There are forward-facing occasional seats above which folding tables are arranged. The tables are mounted on a special fitting that involves the use of only one pivoting link at each side, the forward end of the table having at each front corner a projection engaging with a slide. Between the two separate occasional seats, the lower portion of the division carries three cabinets containing cocktail equipment in the upper and lower cabinets, and a recess for gloves or other small articles between them. The rear seat side arm rests are well arranged, that on the off side carries radio controls and interior light switches. The division switches are on the quarter finishers.

A coachbuilder who adheres to the traditonal method of construction using an ash body frame with metal reinforcement, is Rippon Bros. Ltd., who exhibited a Rolls-Royce Silver Wraith carrying a special sports saloon body. This is a four-door six-light body with well-domed front wings carried rearwards across the doors, a falling line being adopted. Both front and rear wings are attractively swaged and the waist moulding is downswept to run in harmony with the rear wing line, the moulding being split in order that one section shall pass round the front of the wing.

For the length of the door and quarter lights, the waist moulding carries a chromium plated flash that also embodies the door handles. Seating is provided for six persons. The front seat is of adjustable bench type. Folding tables are fitted to the seat back, and there are also a cabinet and clock.

Convertible coachwork has for many years been a feature of the Tickford exhibit, and the two-door foursome coupé shown on a Lagonda chassis made an attractive vehicle. The body frame is of composite construction and is mounted on a steel sub-frame. A three-position head is used, giving an intermediate de Ville position. This head is trimmed with Melloroid and has a particularly large plastic rear window. A large luggage boot is provided and the spare wheel is mounted in a separate compartment beneath the luggage floor.

The convertible body on the Lagonda stand was of particular interest, since it was by Graber, the well-known Swiss coachbuilder. It has a V-screen with substantial pillars and top rail. The instrument board and door finishers are covered in red leather and carry a chromium motif. Space for luggage is provided behind the front seats in wells at each side of the deep central tunnel.

Luggage disposal deserves high priority in the list of worthwhile improvements. It is apparent that, to secure the best results, certain modifications to the chassis are involved. It was evident that considerable benefit results if the fuel tank is removed from the normal position at the rear of the chassis frame where it encroaches upon available luggage space, an alternative position being found in the otherwise empty spaces usually found behind the wheels in the front and rear wings.

Whether the front or rear wings are chosen is a matter that chassis technicians will debate. Examples of each arrangement were used on convertible coachwork exhibited by two car manufacturers. Weight distribution and vulnerability to accidental damage are factors to be investigated, while, since two fuel tanks are involved, the question of a single fuel feed from a balance pipe connecting both tanks, or individual feeds from each is another question to be settled. It is significant that both of the cars exhibited with the modified fuel tank arrangement carry convertible coachwork, a type that usually compares unfavourably with fixed head coachwork as regards luggage accommodation, mainly because the folding head in the interests of appearance is, when folded, partly or wholly concealed in the rear boot.

The science of aerodynamics has played a prominent part in determining the external shape of some of the cars displayed. To secure the utmost benefit, not only in the interests of maximum speed but also to improve fuel consumption, the study must be extended to those parts of the automobile that have no primary sales value, namely the underside of the chassis and wings.

Fuel economy and speed are also greatly influenced by total vehicle weight and whilst the use of light alloy for body construction shows perhaps a slight increase, there is little doubt that a further advance in this direction is desirable. Some car manufacturers and a few specialist coachbuilders have already achieved commendable results, but modern conditions demand that this question of weight reduction must remain a dominant factor.

Frazer-Nash with 2·6 litre Austin engine

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Close-up of window showing shear angle setting.

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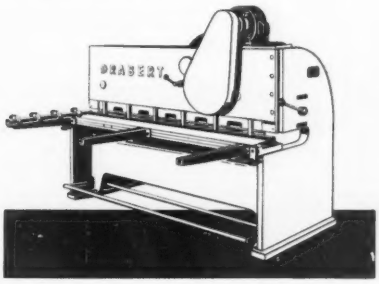

View of smaller machine having 6′ 6″ between uprights.

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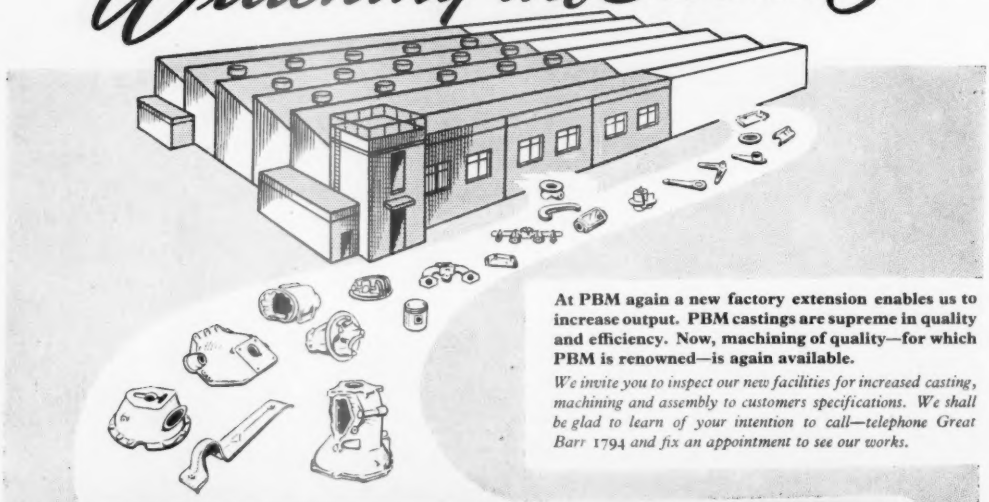

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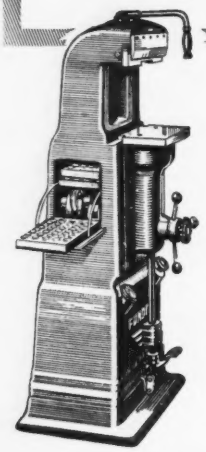

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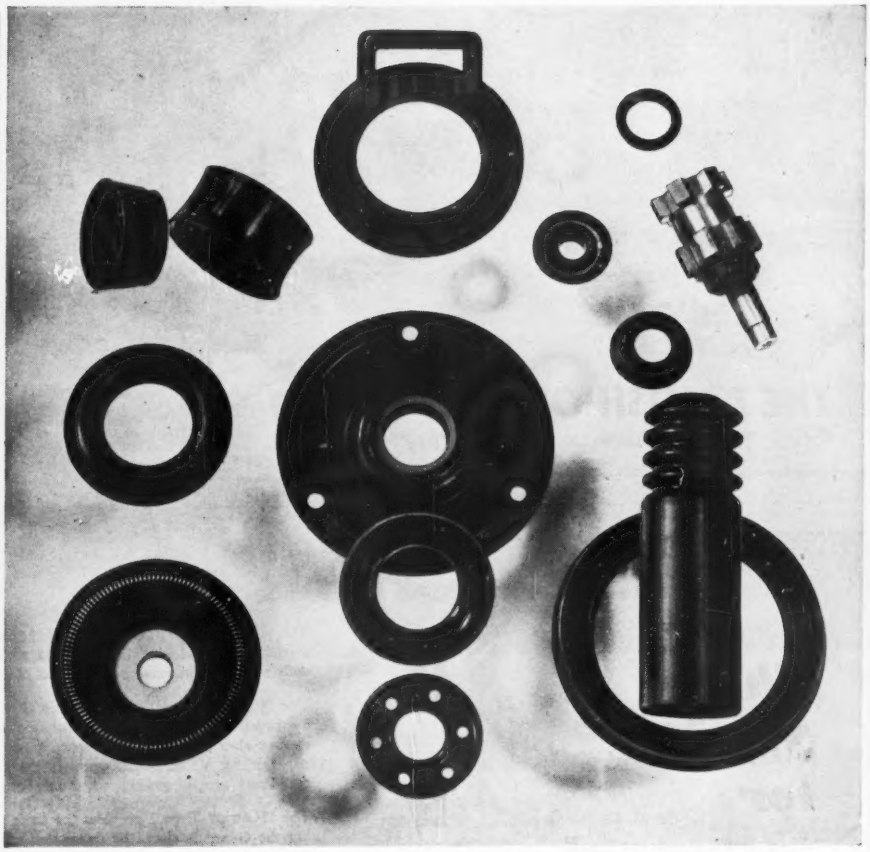

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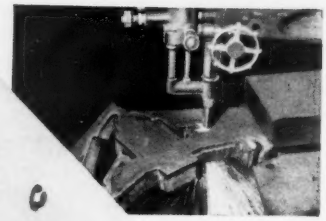

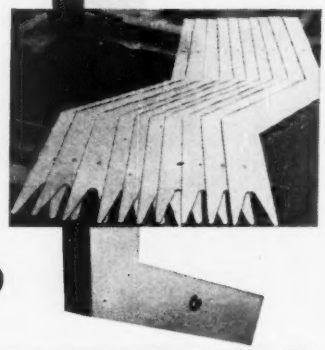

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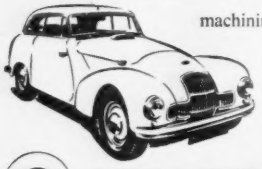

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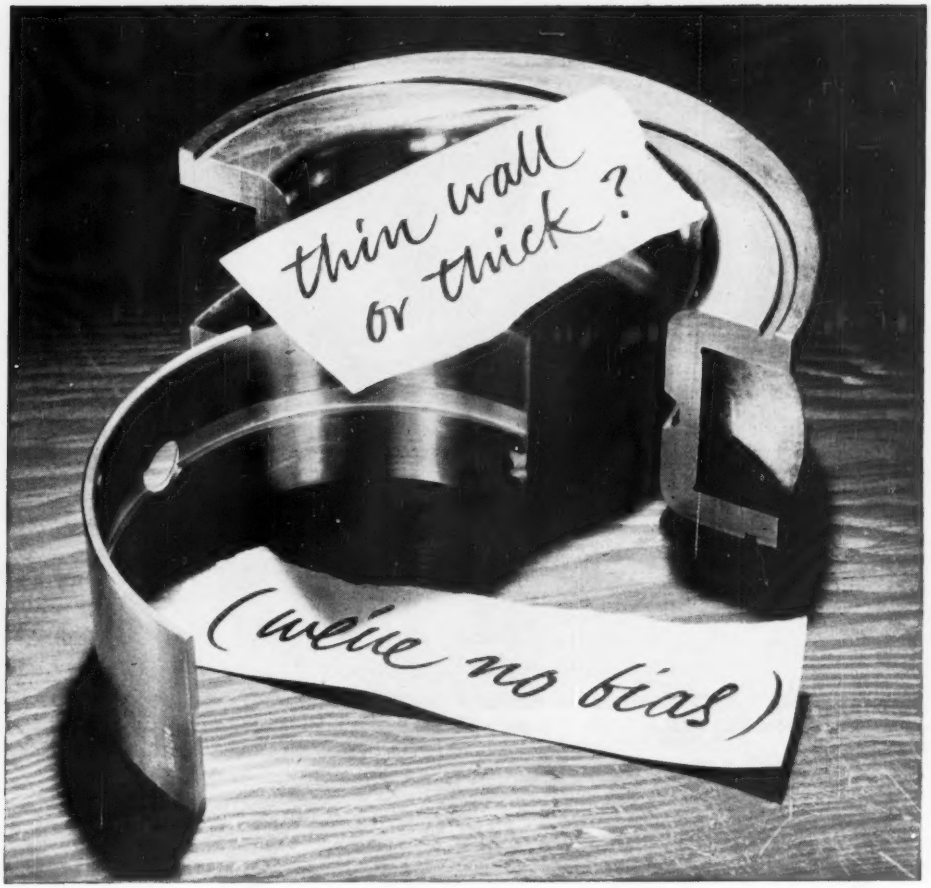

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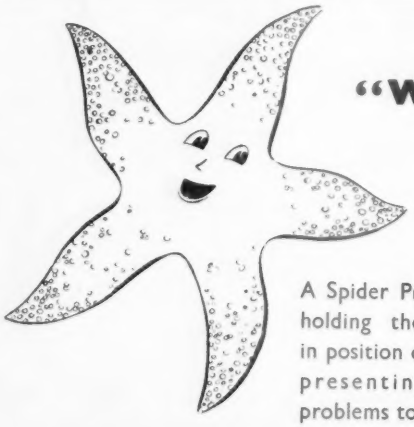

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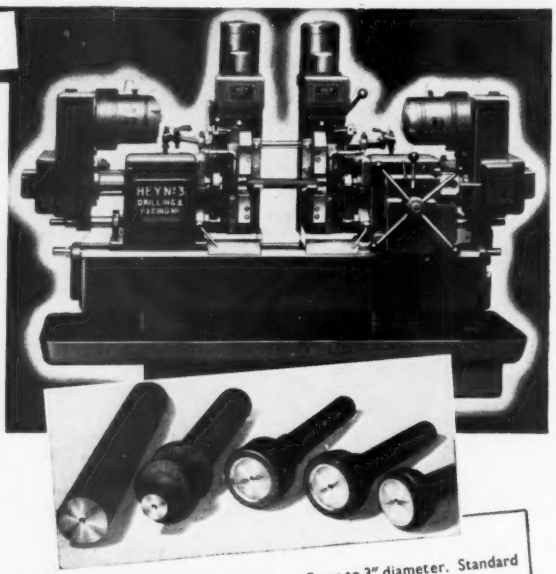

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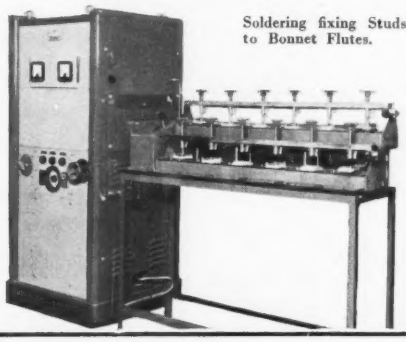

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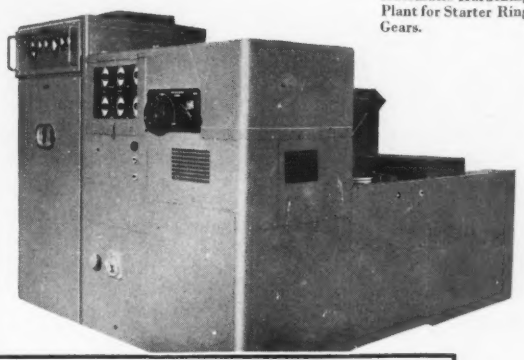

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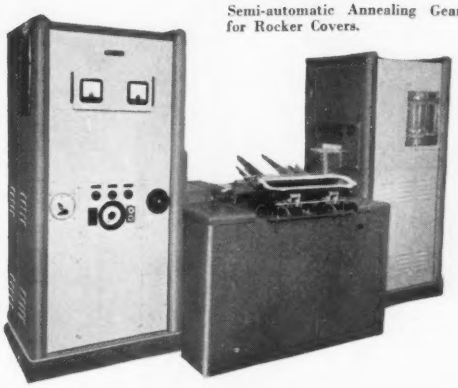

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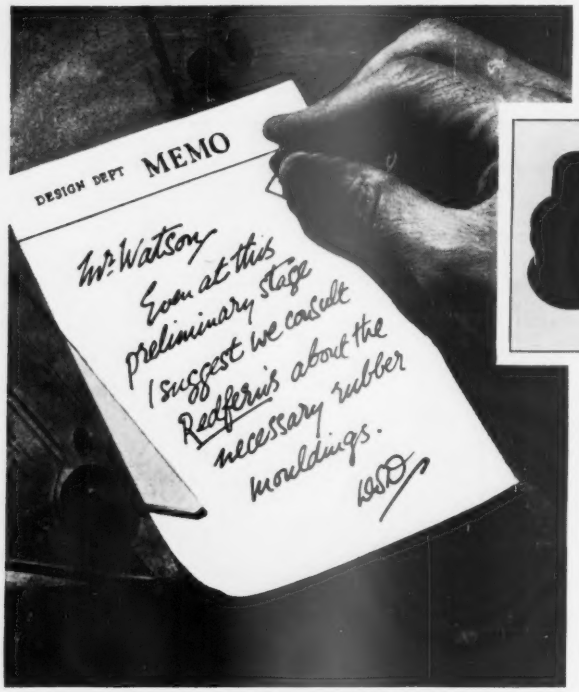

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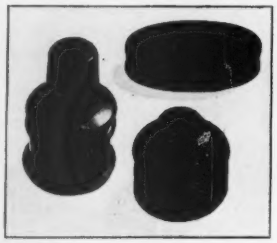

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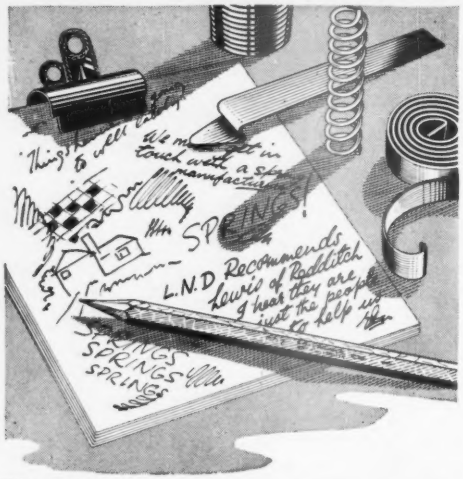

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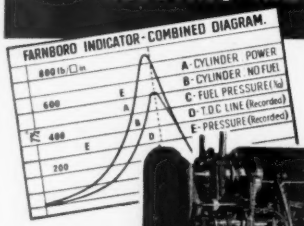

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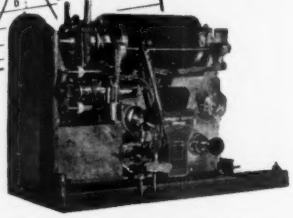

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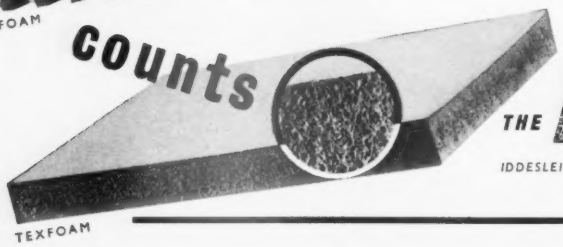
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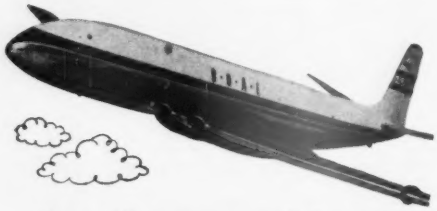

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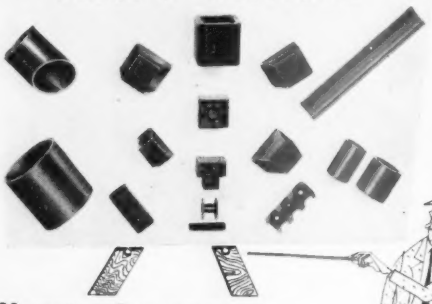

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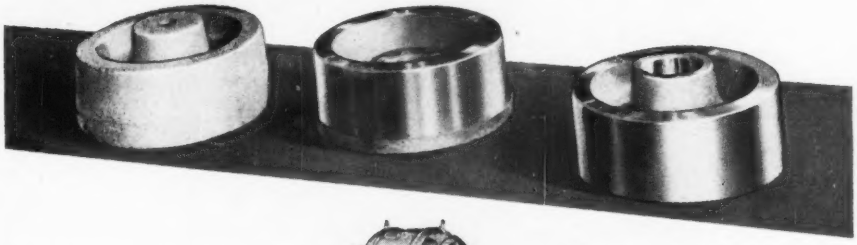

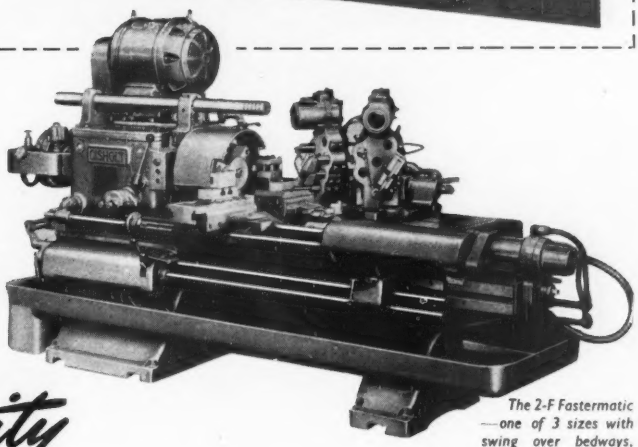

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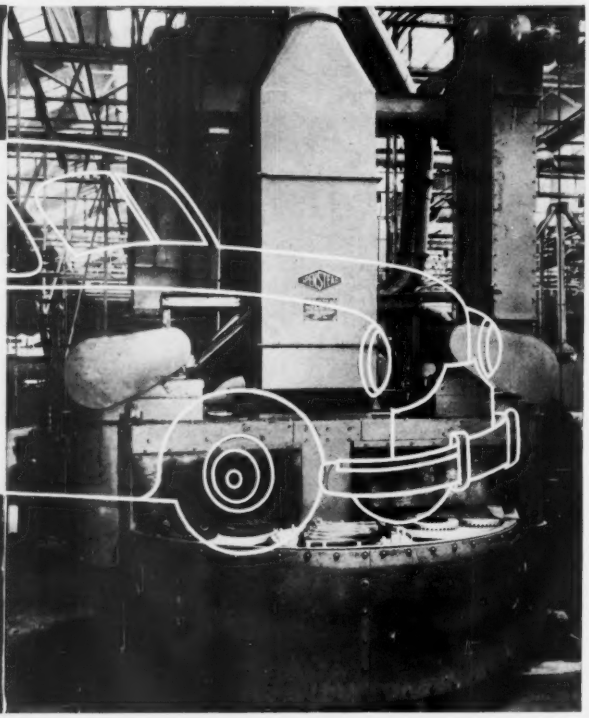

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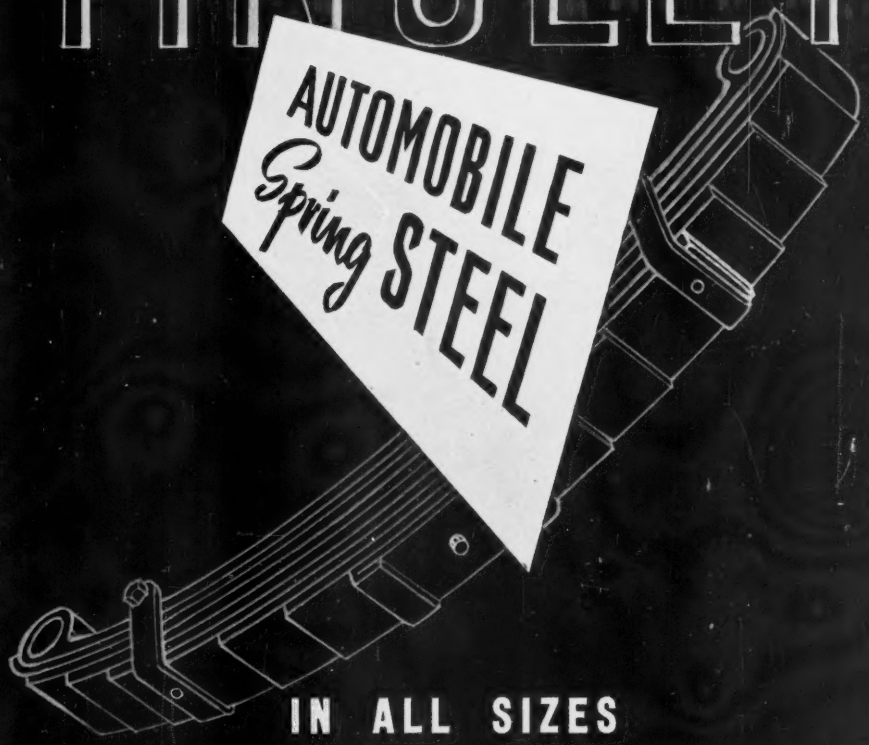

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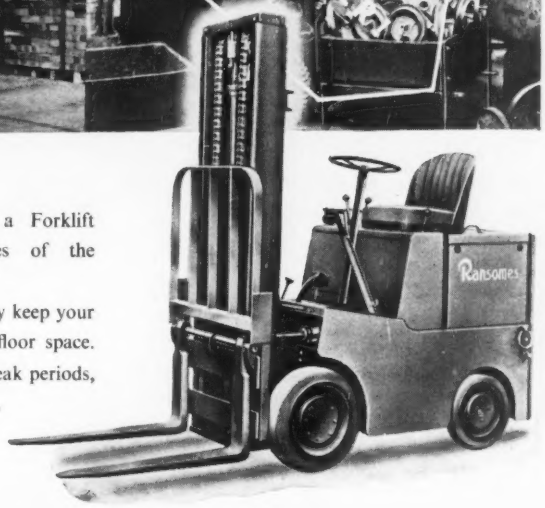

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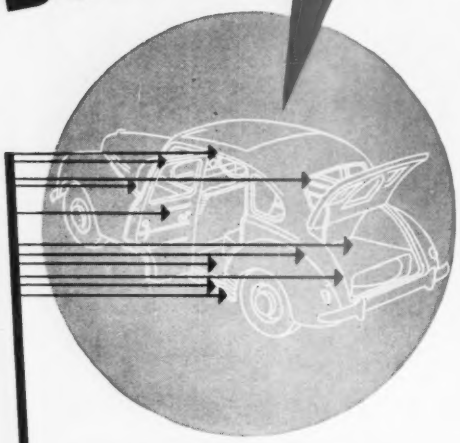

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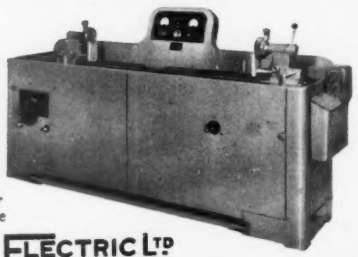

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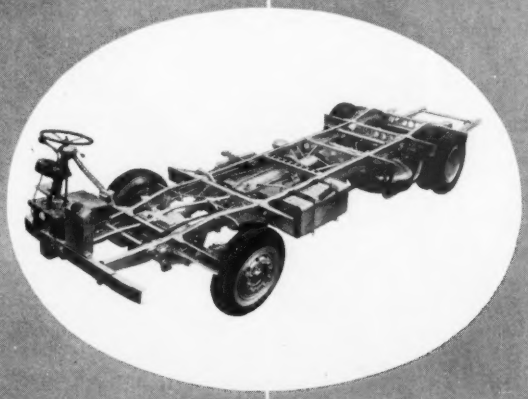

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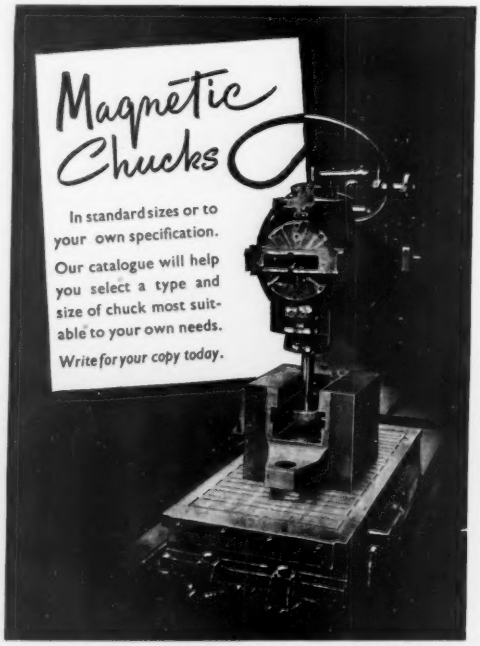
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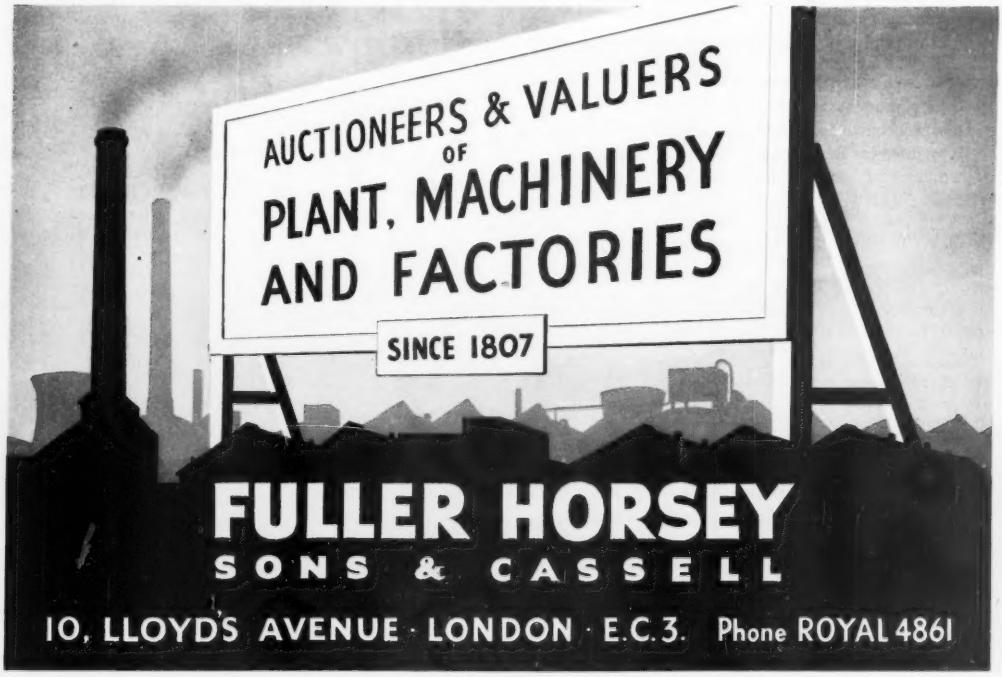

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Photograph shows I-C engine pistons treated with 'dag' colloidal graphite before running-in. (Reproduced by courtesy of The British Piston Ring Co. Ltd.)

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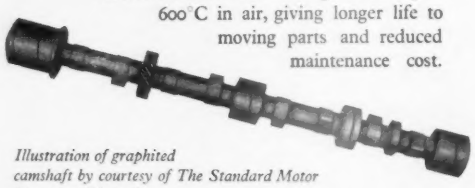

Illustration of graphited camshaft by courtesy of The Standard Motor Company Limited.

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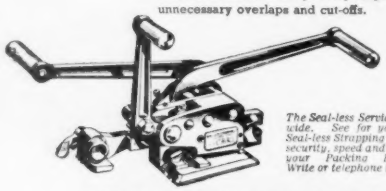

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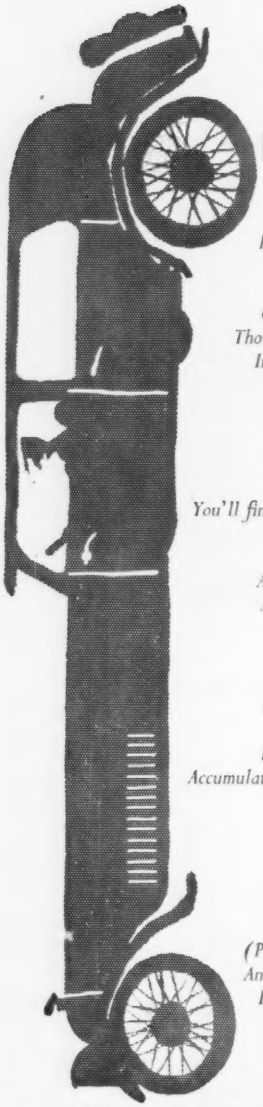

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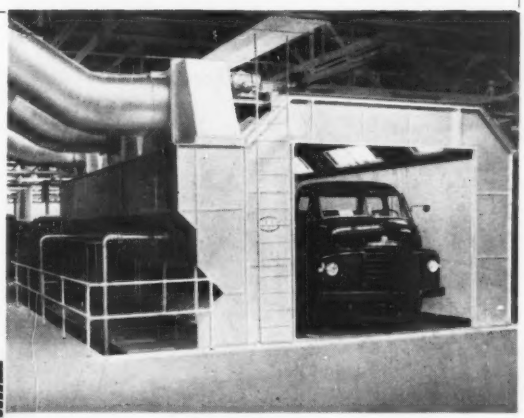

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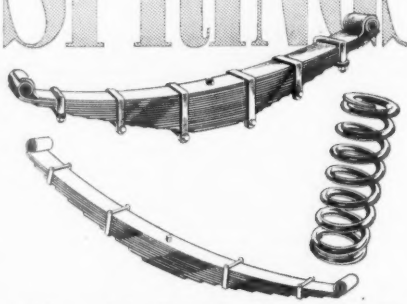

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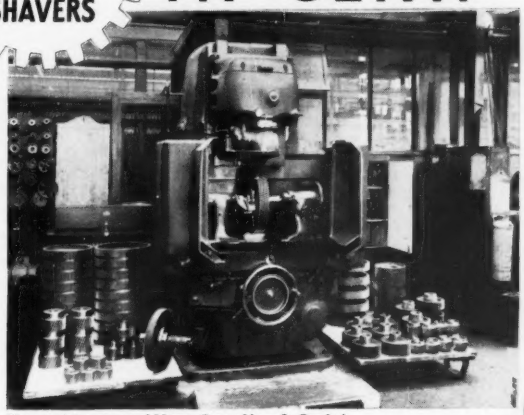

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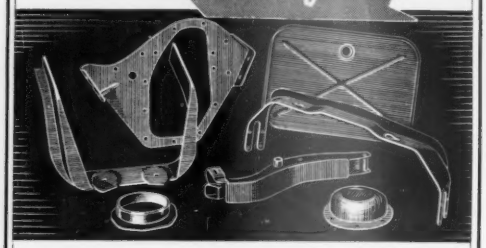

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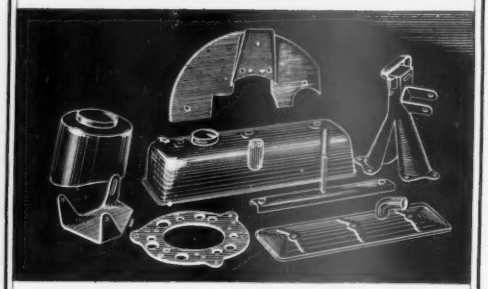

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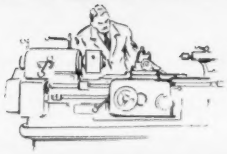

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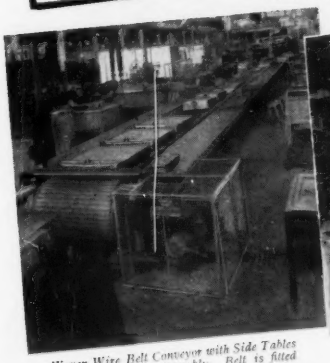

Woven Wire Belt Conveyor with Side Tables for Car Radiator Assembly. Belt is fitted with Centre Guide Rollers. (Photo by courtesy of Vauxhall Motors Ltd.)

Overhead Chain Conveyor automatically discharging Jigs to Gravity Roller Conveyor feeding Footbutt Machine. (Photo by courtesy of Vauxhall Motors Ltd.)

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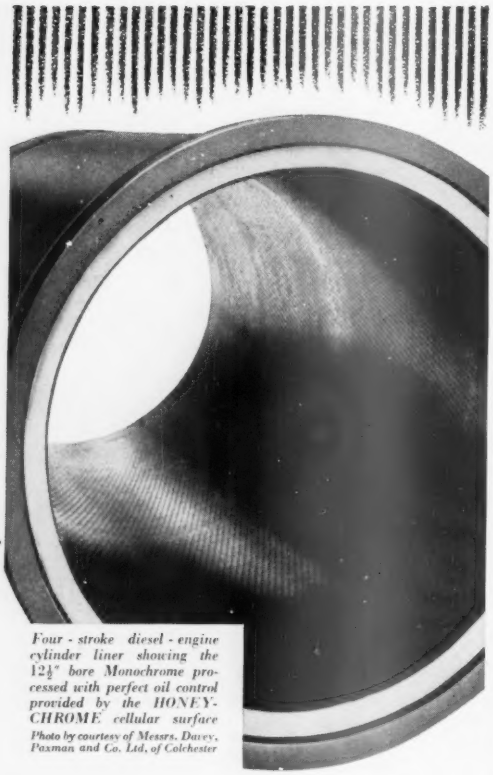

Four-stroke diesel-engine cylinder liner showing the 12½" bore Monochrome processed with perfect oil control provided by the HONEYCHROME cellular surface
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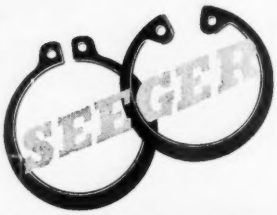

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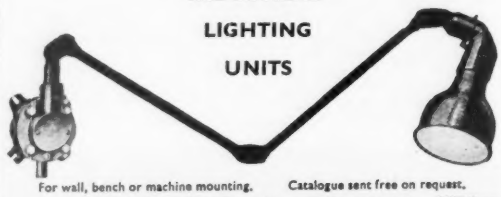

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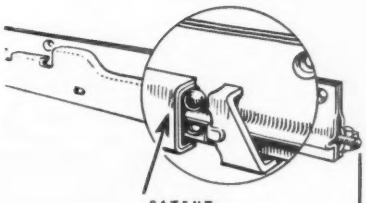

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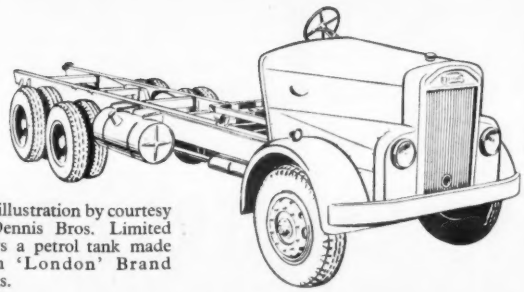

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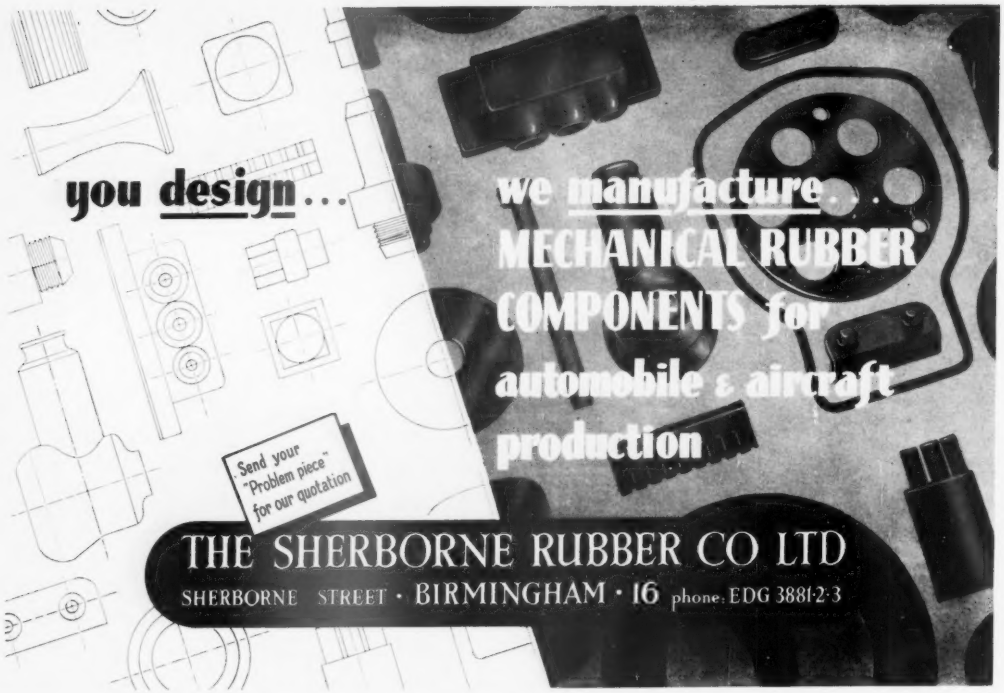

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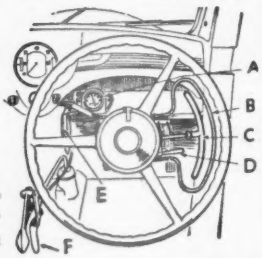

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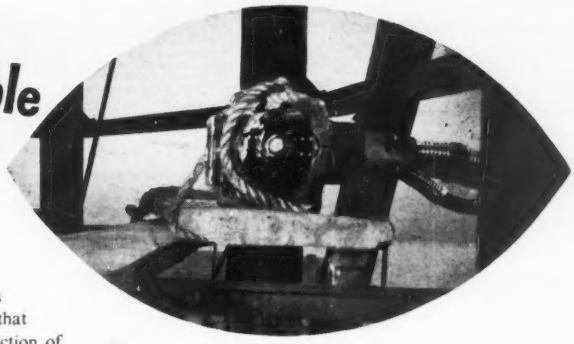

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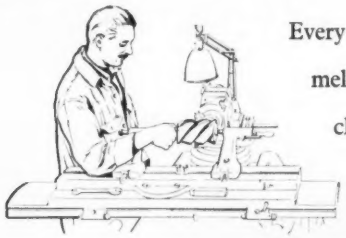

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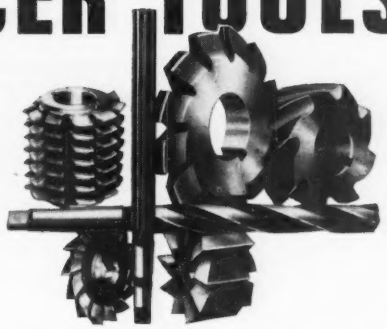

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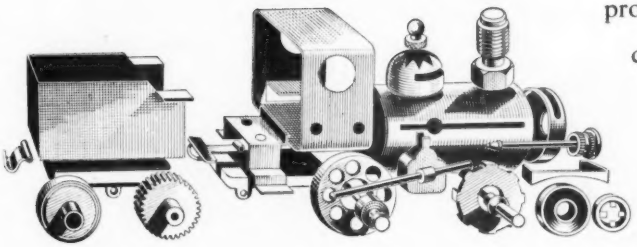

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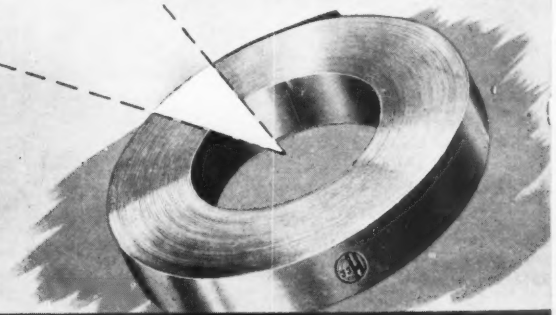

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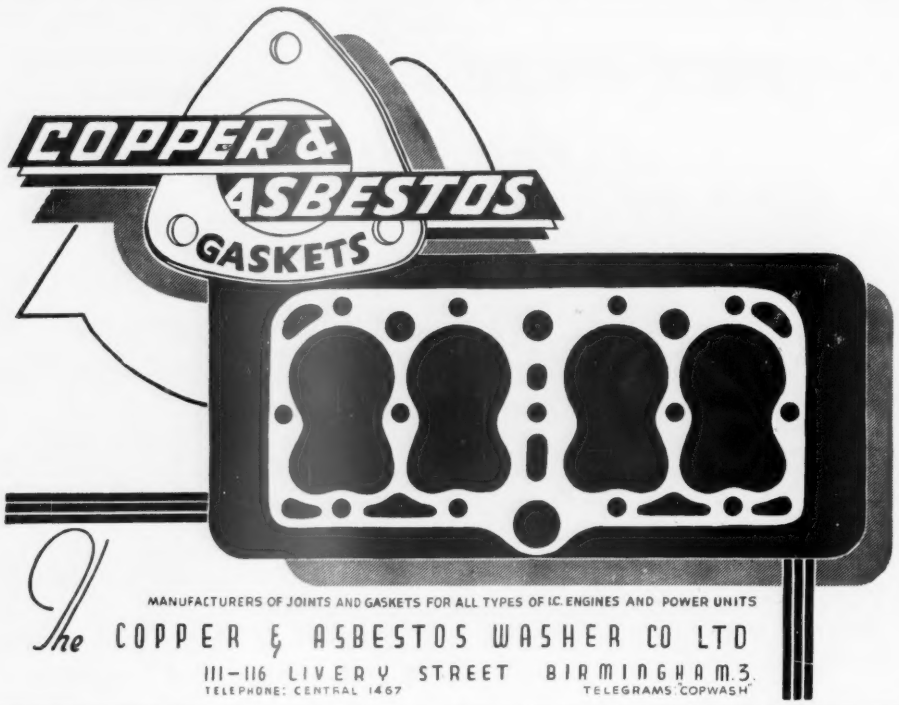

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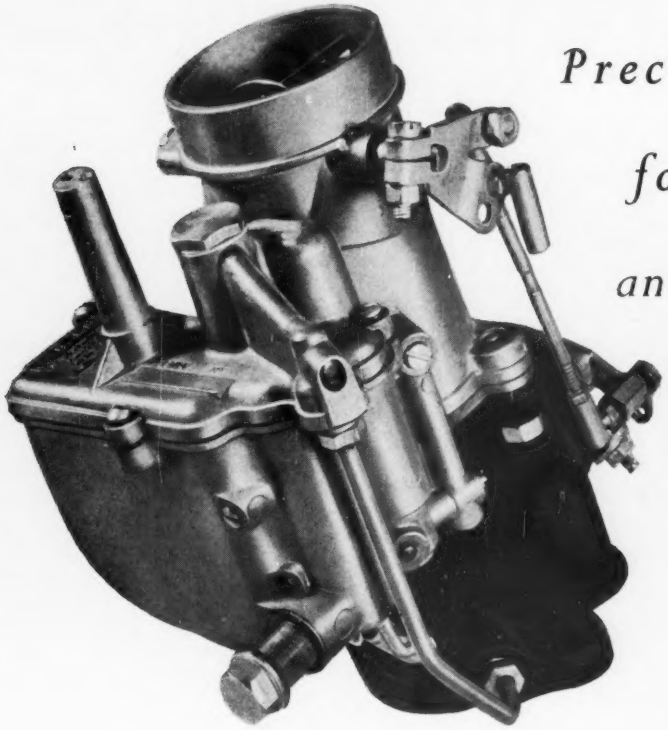

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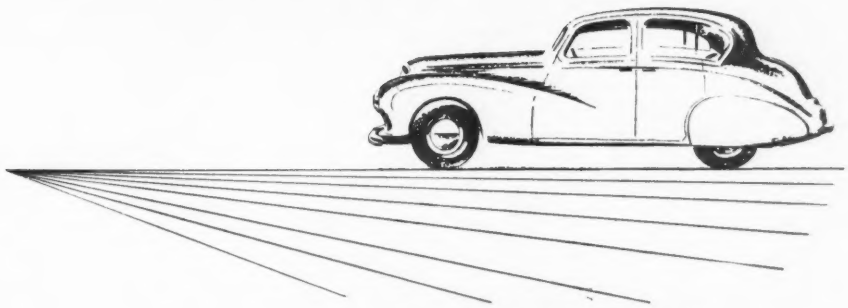

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